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About

The Journal of Turkish Organology (JTO) (e-ISSN: 3023-7890) is a free, open-access, peer-reviewed scholarly journal that publishes research on musical instruments, including their characteristics, classification, historical development, and etymology. The journal employs a double-blind peer-review process. As the first and only academic journal dedicated specifically to organology, initially with a regional focus and subsequently with an international scope, JTO aims to serve as an important platform for the advancement of this academic discipline. JTO encourages researchers in the field of organology to develop their academic writing skills, use of technological tools, and competencies in musical instrument making, design, modification, and restoration. The journal is published biannually, in March and September. The publication language of the Journal of Turkish Organology is English.

Scope

The scope of the Journal of Turkish Organology (JTO) encompasses academic research in the field of organology as well as interdisciplinary studies related to musical instruments. JTO publishes research articles, review articles, book reviews, and interviews. The journal welcomes studies focusing on the characteristics of musical instruments; their historical development and etymology; musical instrument making and design; modifications, innovations, and improvements in musical instruments; and interdisciplinary research on musical instruments.

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Research Article

The Chifte Kaval tradition in the Balkans: A comparative organological study of Bulgaria, North Macedonia and Kosovo

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Abstract

This study aims to comparatively examine the structural characteristics of chifte kaval examples from Bulgaria, North Macedonia, and Kosovo and to reveal the regional diversity of this musical instrument tradition. The research draws upon instruments documented during fieldwork, specimens preserved in museum collections, and relevant literature. Measurements from chifte kavals held in museum collections across Europe and the United States were compiled and compared, including overall length, bore diameter, external diameter, fingerhole arrangement, resonance holes, thumb-hole placement, and construction techniques. The findings indicate that the examined instruments range in length from 515 mm to 812 mm, while bore diameters vary between approximately 11.5 mm and 17 mm. North Macedonian examples made by the Ferati family exhibit a distinctive bore constriction of 14.75 mm near the blowing end, whereas a Kosovo specimen displays a pronounced distal-end restriction of 11.5 mm. Bulgarian examples from the Rhodope region are characterized by narrower bores, different fingerhole spacing patterns, and, in the Beslen specimen, an unusually wide interval between the third and fourth fingerholes. While the Kosovo and North Macedonian instruments share close similarities in morphology and decorative features, the Bulgarian examples demonstrate a distinct regional organological profile. The study further suggests that the construction of chifte kavals is shaped more by inherited craft knowledge and master-apprentice transmission than by standardized measurement systems. By documenting the structural diversity and regional characteristics of chifte kavals, this research contributes new data to the fields of organology and ethnomusicology.

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Introduction

Throughout the Balkans and Eastern Europe, into the Near, Middle and Far East, the Pacific Islands and in the New World among Native Peoples, the end-blown flute, without keys and in a variety of configurations is known to be (or have been) played. In the Balkans the long end-blown flute is known as “kaval” in Macedonian and Bulgarian; “fyell” in Albanian, and “dzamara” in Greek.

In three Balkan countries there has been a tradition of making kavals in pairs - kept in a single case or on a single double-stick holder - that two people may play and be in tune with each other. In Bulgaria these kavals are called “chifte kavali”. Though the word “chifte” in Turkish means “double” there does not seem to be a recent presence of paired kavals in Turkey. As well as Bulgaria, chifte kavals are found in Kosovo and North Macedonia. There is also evidence of chifte kavals having been made in Epiros, Greece, and Albania. This paper deals with chifte kavals found in Bulgaria, North Macedonia and Kosovo, based on travels in Bulgaria and an eight-month stay in what was the Socialist Republic of Macedonia, now known (to the dismay of Macedonians) as “North Macedonia”.

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Chifte kavals are traditionally made of one long piece of wood. The type of wood is European ash (*Fraxinus excelsior*), which is a light, but fairly hard wood. The walls of chifte kavals are frighteningly thin (approximately 2 mm); These instruments must be held on sticks or in a wooden case for protection. In the past the wood of the kaval was often covered with sheep intestine to keep it from splitting and/or developing small air leaks. New instruments' fingerholes would be cut through both the dried intestine and wood. Intestine coverings are found on both Kosovo and Bulgarian chifte kavals that otherwise share few visual design features.

The chifte kaval weighs almost nothing, in contrast to the single Bulgarian kaval, which is traditionally made in three parts, with thick walls, oxhorn joints (often plastic now), a heavier wood, and with a rim of oxhorn to blow across. In North Macedonia chifte kavals have been made both by ethnic Albanians and Slavic Macedonian artisans; in Kosovo by ethnic Albanians, and in Bulgaria by Bulgarian Muslims.

Chifte kavals are chromatic instruments, playing intervals simallar to half-tones, with the exception of the lowest interval, which resembles a whole tone. The "scaling" of the instrument, that is, the relationship of the distance between fingerholes, to the length from the blowing edge to the highest open fingerhole, determines whether the instrument tends to sound flat or sharp playing up the scale. As a folk instrument, it is listened to by an audience not concerned with intonation, including dancers, sheep and sheep dogs. When two shepherds play a set of chifte kavals together, say, in the Shar Mountains with a flock nearby, they will be perfectly in tune with each other. One person will play a melody while the other will play a drone. Given years of playing together, they will learn to take breaths alternately to avoid a sudden silence.

I have a longtime friend, a shepherd who lives near Brno in the Czech Republic, in a covered wagon. Having fallen in love with the sound of the kaval, he had one made, and wrote a few months ago telling me that for the first time his playing has been recognized by his sheep as a sign for them to come into the pen for the night. Some folks who, having played the silver concert flute for years, want to know what it feels like to play an instrument without the mediation of a mechanism, hence are drawn to the kaval.

I wrote about how chifte kavals are made, published in the journal *Ethnomusicology Online* (1998), taking note of the variety made by the Ferati family in the village of Arachinovo near Skopje, North Macedonia. In the article I stated that these paired kavals used to be played in Bulgaria, but to my limited knowledge they were no longer played today. A year after publication I received an e-mail from Bulgarian kaval player and teacher Lyuben Dosev, with a recent picture included of two Bulgarians, each holding one of a pair of chifte kavals. Lyuben wrote that I should not be too quick about stating there is no one left in Bulgaria who plays these instruments!

Aim of Study

The aim of this study is to examine the chifte kaval tradition found in Bulgaria, North Macedonia, and Kosovo from an organological perspective and to comparatively reveal the structural characteristics of these instruments. In addition, the study provides information on kaval-making traditions in the Balkans. Museum specimens, instruments documented during fieldwork, and relevant literature were evaluated together. The study focuses on the dimensions, bore diameters, fingerhole arrangements, construction techniques, and regional variations of chifte kavals. By comparing data obtained from different regions, similarities and differences among chifte kavals were identified, and the characteristics of this instrument tradition that may contribute to the fields of organology and ethnomusicology were highlighted.

Method

An initial search was made for Albanian, Bulgarian and Macedonian literature covering the subject of chifte kavals. As a result it became clear that the crafting of these instruments in Bulgaria was centered around the Southwest Rhodope Mountains, home to Bulgarian Muslims, and that it would be more likely to find these instruments in Kosovo rather than Albania. A search was conducted of musical instrument museums in Europe and the United States. A search was also made of ethnologic museums in Bulgaria, Macedonia and Kosovo. Curators of those museums having examples of chifte kavals were contacted, asking for photographs of the instruments. All curators but one provided photographs. The curators were asked if they would measure the instruments, explaining what particular details were required. All

museums but one (not the same one) agreed to measure the kavals for the article. Measurements were made with metric tape measures. In no case were measurements obtained from photographs provided, due to the distortion inherent in photographing long, thin objects. All measurements were conducted by museum curators. Curators were asked for any additional information about how and when instruments were procured. In one case, the gentleman providing the instrument was available, and was contacted for further information.

Results

After receiving from Lyuben the family name (Terziev) of one these players and their whereabouts, I travelled in 2000 first to Skopje, Macedonia to pick up a friend; next to Sofia, the capital of Bulgaria, then by bus south to the city of Blagoevgrad, and finally by “expedition” of college students, another 147 kilometers due south to the village of Ablanitsa, in the Southwest Rhodope mountains, very close to the Greek border. We spent the late afternoon and evening listening to Ablanitsa residents Arben Terziev and friend play Rhodope melodies. Ablanitsa is one of fourteen villages in the Municipality of Hadjidimovo, all of which have predominantly if not exclusively Muslim populations, as do villages in neighboring municipalities. Below is Arben Terziev (in the jacket) and his longtime friend playing for us.



Photo 1. Chifte kaval players Arben Terziev and a fellow musician performing traditional Rhodope melodies in Ablanitsa, Bulgaria. (Source: Anthony Tammer Personal Archive)

While North Macedonian kavals will have a bore diameter of 15-17 mm, these kavals typically have a bore of around 13 mm. – 15 mm. The instruments were not in tune with themselves, going flat as the scale ascends. In part that can be from a rough bore and/or little recent use. A little vegetable oil poured into the bore to smooth it out would probably have helped.

The wood surface was scored ornamentally with marks that were now so faded as to be barely visible. The geometry of the blowing edge was a simple outside bevel to form a sharp blowing edge. The bottom end was flared out on the outside for strength. Finger-hole placement was similar to Macedonian instruments, but the spacing seemed small for kavals of that length.

I asked about the age of the instruments, and was told they were at least 40 years old. “Were they from Ablanitsa?” Definitely. “What was the name of the maker?” Terziev and his friend looked at each other in silence. It seemed not possible that the flutes would be from Ablanitsa, yet they would have no idea who made them, even if they were made a generation or two ago. Not to be intrusive, I changed the subject to general small talk. Arben picked up a modern 3-piece kaval and played Thracian melodies excellently on it. He had taken lessons, he said, but his real love was not the kaval at all, but the Turkish ney. He would give anything to see one. After some hours passed it was time to go back to Sofia, the first stop on my way back home to California. It would take several trips to find out more about the chifte kaval in Bulgaria. I knew from experience when searching for flutes and flute players in Greece and Macedonia one should not push things: There is much ethnic and national pride wrapped around the subject. At the time I had no knowledge of the publications of Bulgarian ethnomusicologists who had written about these instruments.

In 2005, I found another set of Bulgarian chifte kavals, on display in the Gotse Delchev Historical and Ethnologic Museum. The larger town of Gotse Delchev is a scant 22 kilometers northwest of the village of Ablanitsa.



Photo 2. Chifte kavals attributed to the village of Beslen, exhibited at the Gotse Delchev Historical and Ethnographic Museum, Bulgaria. (Source: Anthony Tammer Personal Archive).

On the third floor of a wonderful old mansion is a glass case holding a set of chifte kavals, and what I saw took my breath away: Chifte kavals whose fingerhole spacing, as you can see above, was not even, but rather had a larger space between the hands, that is, between the third and fourth fingerhole, similar to the Turkish ney (the ney has only three fingerholes for the bottom hand as opposed to the kaval's four). I had never seen kavals before with variable fingerhole spacings. The (then) curator of the museum Spaska Paskova explained that these kavals were made in the village of Beslen: She was quite sure of that. A glance at the map provided below (p. 19) shows Beslen to be close to Ablanitsa.

From Gotse Delchev I hired a taxi to first go back to Ablanitsa, to see Arben Terziev again, to find out if the ney I ordered for him had arrived. It had, his father told me, but Arben wasn't home. Then on to the nearby village of Teplen. There I asked about chifte kavals and was introduced to a middle-aged man, Ahmet Daud Navkof, who told me that there used to be a kaval maker in Teplen, Ali Ahmev, who had passed about 10 years ago. He showed me his pair of kavals, close in appearance to those I had seen a few years earlier in Ablanitsa. One instrument was cracked and unplayable, but the other was in good condition. The cracked instrument - beyond repair - was not discarded, but rather was kept together with its decades-long partner. I asked Ahmet if he would play for me, and he tried, but could not; His fingers were stiff and arthritic, and so I played it. The instrument seemed to jump to life, and was in tune with itself, in spite of not having been played or oiled for heaven knows how long. I asked Ahmet how old the instruments were. He said he didn't know, but thought they were made before he was born, over sixty years ago. I asked what wood they were made of, and was told "Muzhdraf." Years later I learned that in the Southwest Rhodopes European ash wood is referred to as "Muzhdrun" or "Muzhdraf" as opposed to the Bulgarian/Macedonian "Yasen."

So now we have three sets of Bulgarian chifte kavals, two of which seem to have equally-spaced fingerholes, one of which (the teplen kaval) was in tune with itself, while the other (Ablanitsa) was decidedly flat, and the third (Goce Delchev Museum specimen) having unequally-spaced fingerholes. I could not believe these variations would be produced by one kaval maker. Younger members of the kaval-making family are carefully trained, over years, to make them. Liman Ferati, kaval maker in Macedonia, had said his son would take eight years of training and practice to reliably make a chifte kaval set, as he, Liman, was trained by his father, İslam.

My fascination with these one-piece flutes stems in part from the way they are made: out in an open yard, without the need of powered machines, rulers, or anything so heavy as to be an impediment to the migrations of a transhumant pastoral people. Made without regard to a musical key, the length of the instrument is traditionally requested by a customer in terms of fists placed one over the other on a stick; the spacing of the fingerholes being measured in finger-widths (a longer flute means the maker presses his finger harder on the wood, creating a wider space between fingerholes).

In 1960 the Bulgarian ethnomusicologist Ivan Kachulev, along with several other ethnomusicologists, made an excursion to the Southern Rhodopes. Kachulev's resulting article *Narodnite Instrumenti I Instrumentalna Musika Na Bulgarite Mohamedani V Rodopite* [Folk Instruments and Instrumental Music of the Bulgarian Muslims of the Rhodopes] (1962) includes several photographs of chifte kavals: kavals on display at the Institute for Music, in Sofia;

another set from the musical instrument museum in St. Petersburg, and chifte kavals played by musicians in the Rhodope villages of Sarnitsa and Nastan (the latter now incorporated into Devin). The Nastan kavals were made in three pieces. The Sofia and St. Petersburg instruments were thought by Kachulev to have been made in the village of Beslen, which he considered to be a center of chifte kaval-making.¹ Poor roads and bad weather prevented Kachulev from travelling to Beslen, and it is unclear whether he ever did visit the village.

Kachulev explains that to prevent these thin-walled kavals from cracking or leaking air, they are encased in the intestine of a young lamb. My woodworking friend and Bulgarian gaida (bagpipe) player Hector Bezanis noted that this was a popular procedure in the past, showing me a dramatic picture of a Serbian kaval covered with the skin of a snake. In the Instrument Museum of the Royal Conservatory of Music in Brussels are two sets of chifte kavals, with case, said to be made of “intestine and wood.” The instruments were procured “before AD 1899.”²

The first page of Kachulev’s article extols the Bulgarian national purity of Muslims living in the Southwest Rhodopes: Their Bulgarian language usage for instance, is pure. The 1962 excursion of ethnomusicologists into this area of the country was taking place in the context of a climate of increasing persecution of Bulgaria’s minority populations: In 1962 Bulgarian Muslims were forbidden to attend Turkish-language schools. It got horribly worse from there (Kamusella, 2019).

Eleven years after the publication of Kachulev’s work, the ethnomusicologist Manol Todorov published his *Bulgarski Narodni Muzikalni Instrumenti* [Bulgarian Folk Musical Instruments] (1973). His dated list of informants indicates that he had been interviewing musicians throughout Bulgaria for at least ten years (1962-1972). In the book he cites 73 informants, two of which, a father and son, interviewed in 1972 in the town of Nastan, Smolyan Municipality (in the Southern Rhodope Mountains) played chifte kaval.

Todorov also had viewed the chifte kavals in the St. Petersburg State Institute of Theater, Music and Cinematography collection of musical instruments, as exhibit 1885-B, procured in 1872. He commented that the chifte kaval is thus “e mnogu stara narodna muzikalna traditsiya” [a very old folk music tradition.] (p.48). It is interesting to note that in 1872 the territory of the Southern Rhodopes, including the town of Serres, was considered a part of Macedonia (Kanchov, 1900) and would remain under Turkish rule until 1912. In the Saracatsan³ Museum of Serres there is a single kaval with case that looks very similar to those residing in the Gotse Delchev museum.

Todorov describes in general how three-part kavals are made, using a “primitive” lathe. He does not describe how chifte kavals (a single-piece wooden kaval) are made. Chifte kavals are not turned in a lathe but are cut to cylindrical size, after hand boring, with a hand-held drawknife. Considering Kachulev’s and Todorov’s writing, and my own observations, chifte kavals were found in the villages of Ablanitsa, Teplen, Barutin, Beslen, Nastan, Sarnitsa, and possibly Velingrad.



Photo 3. Kosovan chifte kaval players from Prizren, photographed by Peter Brömse in the 1930s. (Source: Brömse, 1937)

Across the northwestern border of North Macedonia lies what is now (since 2008) the Republic of Kosovo. Much of Peter Brömse’s excursion as related in his 1937 book *Flöten, Schalmeien, und Sackpfeifen Süd-Slawiens* [Flutes, Shawms, and Bagpipes of the South Slavs] takes place in Kosovo, which was then - along with Macedonia - a part of the

Kingdom of Yugoslavia. Brömse provides a picture of two Kosovans (Photo 3). I placed these folks in Skopje. In fact they might have been playing in their hometown of Prizren, the second most populous city in Kosovo. The two musicians are from Prizren but lived in Skopje.



Photo 4. Kosovo kaval attributed to Uke Maksute the Elder, Djakova (Gjakova), Kosovo, preserved in the Stearns Musical Instrument Collection, University of Michigan

Pictured to the above is a Kosovo kaval in the Stearns Musical Instrument Collection at the University of Michigan. Dimensions are below. This kaval was purchased in Djakova, Kosovo, in 1971 by Prof. William Lockwood, an anthropology professor at the university. The kaval was given by him to the university in 1999. Collection information informs us the kaval was made by Uke Maksute the Elder, an ethnic Albanian from Djakova, born in 1909. So Uke was 62 years old when Prof. Lockwood purchased the kaval. The collection description relates that Uke learned his craft from Djakova craftsman Praksi Deceli. It is hard to see, but the designs on the kaval depict two snakes, undulating on either side of the fingerholes. Doli ((2009) discusses the snake symbol as bringing good luck in his doctoral thesis. There is no information to suggest this instrument was one of a pair, but the known prevalence of paired kavalis in Kosovo would make it likely. I could find no reference to Maksute or examples of his kavalis in the ethnographic museum of Djakova.

The distal end of the Kosovo kaval in the Stearns collection has a restriction at 15 mm from the bottom end, down to a diameter of 11 mm and below this a bell shape carved out to the end of the instrument. The Greek musicologist Fivos Anoyanakis (1992, pg. 148) explains cryptically that the reduction “is required for the expulsion of air” from the instrument. Griffiths (1999) found this restriction in some Albanian kavalis. Evidently Greek and Albanian kavalis sometimes included this feature as well.



Photo 5. Internal bore restriction at the distal end of a Kosovo kaval, showing the reduced opening characteristic of some Balkan kavalis. (Source: Anthony Tammer Personal Archive)

The life history of another Kosovo kaval maker and musician, Shaqir Hoti (1936-2021), has been recorded and transcribed by *Oral History Kosovo* (2015). Filled with the joy of music and the horrors of war, it is well worth reading the 24-page transcription. The URL is listed in the bibliography. A sample of his musicianship has been recorded and is listed in the small collection of YouTube videos here. One of his chifte kavalis is measured here.

Ramadan Sokoli is a noted authority regarding Albanian folk music. In his book *Veglat Muzikore Te Popullit Shqiptar* [Musical Instruments of the Albanian People] Sokoli has little to say about chifte kavals, but when he does mention them, he refers to Kosovo:

It goes without saying that in order to play well, both instruments must be identical, which is why in some areas of northeastern Albania, and especially in Kosovo, long chift kavalli (two flutes) of identical dimensions and holes, placed on a forked rod, are used. (Sokoli, 1991, p.99)



Photo 6. Decorated handle of a wooden sipki used for storing paired chifte kavals, Kosovo. (Source: Horniman Museum, London, Item M30.6.53/1).

“Placed on a forked rod” refers to the unique feature of storing Kosovan and North Macedonian chifte kavals: A single slab of hardwood (usually beech) is cut and shaped to provide two sticks - “sipki” - of about ½” inch diameter, joined at one end, and slightly longer than the length of the kavals it would hold. Thus the matching kavals are held as one entity. The joining end, a kind of handle, is carved to various shapes by different makers. Holes are drilled in the ends of the sticks, and bits of rags of stuck through the holes. These are soaked in an oily substance, to coat the inside of the kaval. Here is an example of a carved handle of the sipki, from a specimen in the Horniman Museum of Musical Instruments, London (Item M30.6.53/1). This instrument pair was acquired in 1953, coming from the area of Peja, Kosovo, and was originally covered with sheep intestines. The fingerholes appear to be equally-spaced, and the distal end is carved into an octagonal shape. The bottom picture bellow shows the distal end of a Ferati family kavals made in Arachinovo, near Skopje, North Macedonia. Unfortunately, the Kosovo instrument could not be measured for this article



Photo 7. Comparative details of Kosovo and North Macedonian chifte kavals. Upper left: distal end of a Kosovo chifte kaval from the Horniman Museum, London. Upper right: distal end of a Ferati family chifte kaval from Arachinovo, North Macedonia. Lower left: carved terminal ornament of the Kosovo specimen. Lower right: carved terminal ornament of the Ferati family specimen. (Sources: Horniman Museum, London; Anthony Tammer Personal Archive).

I do not dwell upon the Ferati family of kaval makers here since they are the subject of my previously published article *Kavals and Dzamares: End-blown Flutes of Greece and Macedonia* (1998).

Perhaps this octagonal carving above is vestigial ornamentation reminiscent of black-powder smooth-bored musket barrels of past centuries, many of which were forged octagonal at the breech end.⁴ Note the rhombus relief carving at the head of the Horniman Kosovo and Ferati kavals. The similarity may be the result of the Ferati family having originally

come from Tetovo, very close to Kosovo, at a time when there were no borders. Of course, these similarities are “merely” ornamental or symbolic (rhomboids are associated with fertility), having nothing to do with the acoustic design of the instrument. This is not, however, the view of the kaval maker. We are used to separating ornamental from functional design features, but the kaval maker considers all features of the instrument to be an essential part of the definition of the kaval. Any discussion with the kaval maker Işlam, I found, about the purely “ornamental” led to instant confusion.

As an exchange student to Skopje, Macedonia in the mid 1970’s, I studied Macedonian kaval with two elderly men and played with the Skopje group “Vlado Tasevski”. During this academic year the only kavals I saw in Macedonia were chifte kavals made by Islam Ferati, residing in the nearby village of Arachinovo. I had no idea of the existence of another ethnic Albanian kaval maker, Salla Shabani, who was making kavals (among other instruments) in his Gostivar workshop. Bekim Ramadani’s recent article (Ramadani, 2025) is about this skilled instrument maker. Shabani was not only an instrument maker; He was a teacher of kaval, and his teaching activities have helped lead to a revival of kaval playing today among adult ethnic Albanians in North Macedonia. Shabani and his students - named in Ramadani’s article - may be heard on a plethora of YouTube videos. At this date (January 2026) The name Salla Shabani itself calls up more than 20 YouTube videos.

The Musical Instrument Museum of the New York Metropolitan Museum of Art holds a collection of Macedonian folk instruments, acquired in 1946: a chifte kaval set (object 1976.8.6a-c); gaida (bagpipe); shupelka; (short diatonic end-blown flute); dvojnika (double whistle), and zurla (shawm) all made by instrument maker Velko Janjevich, of Skopje, Macedonia. The kavals are said to have been made in 1937. Measurements are given on Pg 17.

What kinds of variation do we find in the various chifte kavals in Bulgaria, North Macedonia and Kosovo? These instruments are all made from the same wood. They are all thin-walled, with the same pattern of fingerholes and “resonator holes” below the bottom finger hole, except for the Shakir Hoti instruemnts, which have two rather than three resonator holes. Also, the chifte kavals made by the Ferati family have tapered inside diameters at blowing edge. A bore of 15, 16 or 17 mm is tapered down to 14.75 mm in the top 17mm of the instrument. This taper creates a breathy, intense tone. The diameter of the blowing edge for Ferati kavals is determined by using the shell casing of a “Turks Martini” rifle, whose head diameter is 14.75 mm. The casing head should just fit inside the blowing diameter. No other chifte kaval set in this article has this taper. We have also seen that at least one set of Kosovo chifte kavals was restricted at the distal end. The fingerholes size is always small, and does not vary within a particular kaval set. There is a great difference in overall length: from 515 mm to 812 mm.



Photo 8. Velko Janjevich playing the gaida (bagpipe) in Skopje, Macedonia, photographed by Peter Brömse in the mid-1930s. (Source: Brömse, 1937).

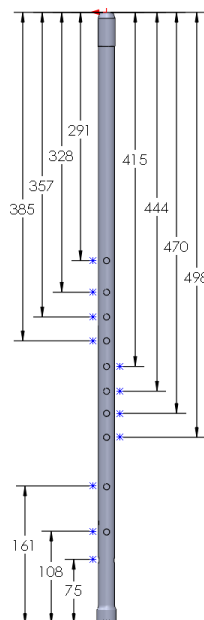
A feature I thought would remain the same was equally-spaced fingerholes. Bromse noted that all of the musicians he interviewed were adamant that the fingerholes must be evenly spaced, though no one knew why. However, the Beslen kavals in the Gotse Delchev museum are shown not to have equally-spaced fingerholes. An inspection reveals that the Stearns Kosovo kaval also has a larger spacing between 3rd and 4th fingerholes, though not as pronounced as the Gotse Delchev example. The Bulgarian chifte kavals held in the National Ethnographic Museum in Sofia have fingerhole spacings that increase incrementally as the holes depart from the blowing edge. There is great variation in the bore diameter. We see a range in bore size of from 11.5 mm to 17 mm. In some of the kavals shown here the distance from

the thumbhole to the first fingerhole is quite large. The same is true of the distance from the last fingerhole to the back hole signifying the lowest note of the instrument. Though the kaval is mainly a chromatic instrument, the first (lowest) interval is closer to a whole tone. In general appearance the Kosovo kavals and North Macedonian kavals made by ethnic Albanians appear to be one branch, while the Bulgarian chifte kavals seem to be another. Closer to the Kosovo branch are specimens of Greek chifte kavals from the area of Epirus, an area once associated with kaval-making.

In the following pages I provide schema for the variety of chifte kavals presented above. The intent is to provide a starting point for anyone wishing to bring to life one or a pair of chifte kavals from as far back as “before 1899”. A good material to start the process would be hard maple. A 30” length of maple, 1” in diameter (pool cue material) may be purchased for about \$15.00. The first step, after cutting to length plus perhaps ½ inch, is to drill through the length of wood. I use Eldorado brand gun drills for this, but these drills do require a steadying drill guide in front of the wood. Once the drill is inside the wood it runs true. These gun drills are hollow, and compressed air can be used to blow out chips.

It is impossible to predict the intonation of kavals simply by looking at the schema. The reason is that the instrument must be held with at least two fingers minimum to prevent it from falling. These fingers cover holes, which change the intonation. The finger positions will change according to what notes are sounded, all leading to an overwhelmingly complex system. Only by playing an instrument over time can the player learn its characteristics and make adjustments with the next instrument.

Chifte kavals made by İslam Ferati, Arachinovo, Macedonia, mid 1970’s.



Length of the instrument = 717 mm

Bore diameter = 17 mm

Blowing edge diameter = 14.75 mm

Body diameter = 20.5 mm

Fingerhole diameter = 7.5 mm slightly oblong

Thumb hole is at 291 mm bored through the back.

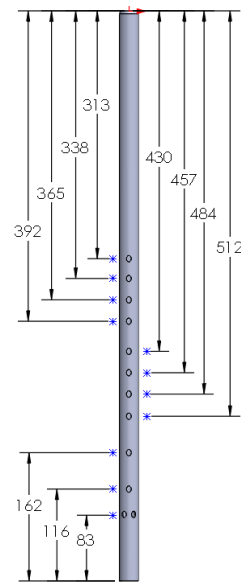
Holes at 75 mm from bottom are bored thru both sides

Hole at 161 mm from the bottom is bored through the back.

Ferati kavals are carved octagonally at the distal end, not shown here.

Figure 1. Technical drawing showing the dimensions, bore diameter, and fingerhole placement of a chifte kaval made by İslam Ferati, Arachinovo, North Macedonia (mid-1970s)

Chifte kavals on display at the Gotse Delchev, Bulgaria Historical Museum. Maker unknown, said to be made in the village of Beslen.



The length of the kaval is 720 mm.

Internal diameter at the distal end was measured at 12 mm.

The thumb hole at 313 mm is bored through the back of the instrument.

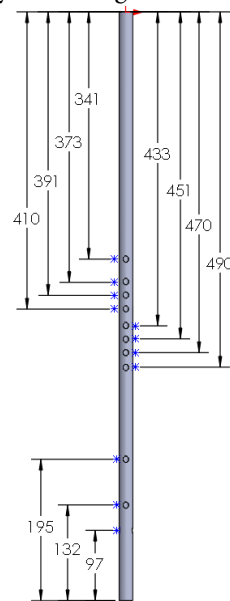
The hole at 162 mm is bored through the back of the instrument.

All holes are elliptical, 6 mm wide by 8 mm long.

The two resonance holes at 83 mm are 17 mm apart from center to center.

Figure 2. Technical drawing showing the dimensions, bore diameter, and fingerhole arrangement of a chifte kaval attributed to Beslen village and preserved at the Gotse Delchev Historical Museum, Bulgaria

Stearns Collection University of Michigan Kosovo Kaval. Maker: Uke Maksute the Elder



Length is 812 mm

Bore diameter is 17 mm

Body diameter is 20 mm

Hole diameter of plug at distal end is 11.5 mm

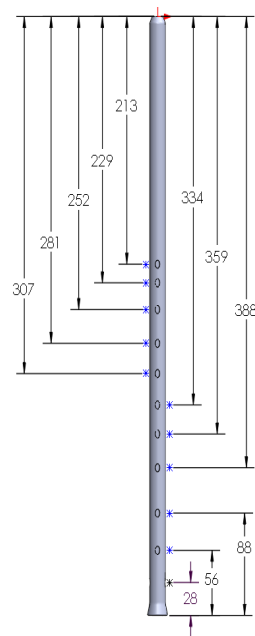
Resonance holes are bored through both sides at 97 mm.

The distance from the distal end to the face of the obstruction is 15 mm

The thumb hole at 341 mm is bored from the back

The hole at 195 mm is bored from the back

Figure 3. Technical drawing showing the dimensions, bore diameter, fingerhole arrangement, and distal-end restriction of a Kosovo kaval made by Uke Maksute the Elder (Stearns Musical Instrument Collection, University of Michigan)



The length of the instrument is 515 mm
 The thumbhole at 213 mm is bored from the back.
 The hole at 88mm is bored from the back
 Bore Diameter is 11.3 mm
 (There might be contraction due to age.)
 Body diameter = 17 mm.
 Resonance holes are bored through both sides at 28 mm
 The fingerhole size is 7 mm long by 5mm wide

Figure 4. Technical drawing of Bulgarian chifte kaval item 2400, Royal Museum of Arts and History, Brussels (before 1899)

Bulgarian Chifte kaval item 2400 in the collection of the Royal Museum of Arts and History (Brussels), Musical Instrument Museum. The acquisition date is listed as “before 1899”. Maker unknown.

Of interest to note is that the thumbhole is (within .5 mm) one-half the length of the distance between the blowing edge and the back hole at 88 mm. Were these three elements carved first, then used to lay out the remaining fingerholes of the instrument?

More Photos of the Brussels Chifte Kaval, possibly made in Beslen.



Photo 9. Bulgarian chifte kaval from the Royal Museum of Arts and History, Brussels, possibly made in the village of Beslen. (Source: Royal Museum of Arts and History, Brussels)

Many decades of storage have taken their toll on these instruments. The upper two kaval are partially covered in remaining sheep intestine.



Photo 10. Flared distal end of a Bulgarian chifte kaval, Brussels collection. (Source: Royal Museum of Arts and History, Brussels).

The flair at the distal end provides protection from cracking. The bore is narrow on these instruments (roughly 13 mm here) compared with the 15-17 mm bore of the Kosovo and North Macedonian kaval.

The blowing edge is a bit battered in this example. In general, the blowing edge is not required. To be very sharp. An example is the small, Greek end-blown flute, the floghera designed by the musician Aristides Vasilaris. Vasilaris incorporated every possible design feature to make the instrument sound less strident. The blowing edge of this instrument is created by simply rounding off the outside diameter, thus creating an edge of 90 degrees.



Photo 11. Detail of the blowing edge of a Bulgarian chifte kaval from the Royal Museum of Arts and History, Brussels.

Bulgarian kavals held in the National Ethnographic Museum, Sofia. National Ethnographic Museum, Item IM-5 Institute of Ethnology and Folklore Studies, Bulgarian Academy of Sciences. The case holds two matching kavals. Information concerning makers and dates when instruments were transferred from the Institute for Music Studies.

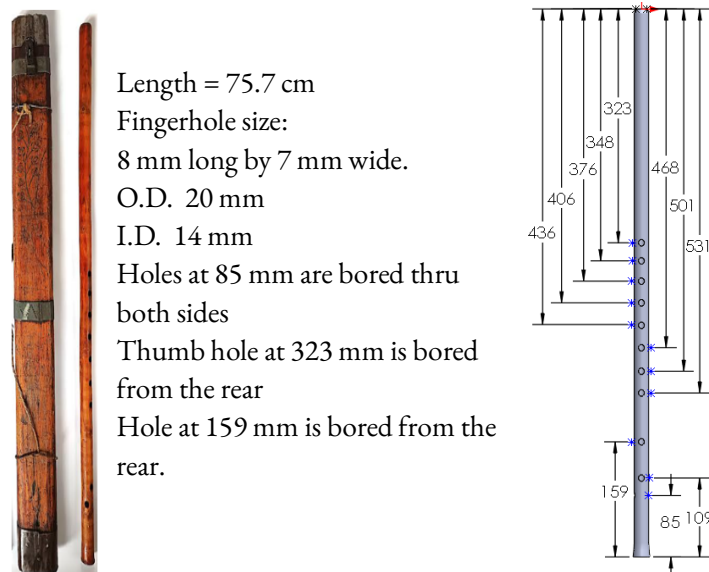


Figure 5. Photograph and organological schema of Bulgarian chifte kavals (Item IM-5), National Ethnographic Museum, Sofia

North Macedonian Kaval by Trajko Korunosky, residing in the Phoenix Musical Instrument Museum. Presented to the museum in 2009 by musician Stefche Stojkovski. Mr. Korunoski was from the city of Prilep. Stefche purchased these and other kavals from Trajko in 2005 during a gaida (bagpipe) festival in the village of Dolneni (16 kilometers northwest of Prilep). The Phoenix MIM could not provide a picture of the korunosky kaval. Mr. Stojkovski graciously provided me with his own. Measurements provided by Phoenix Musical Instrument Museum Personnel.

Length: 751.5 mm
 Bore: 15.7 mm
 Body diameter is 20 mm.
 Thumb hole at 317 mm
 is bored from the back.
 Hole at 169 mm
 is bored from the
 back.
 Two holes at
 79 mm are bored
 Through from the sides
 Finger hole size is
 7.7 mm wide by
 8.8 mm long

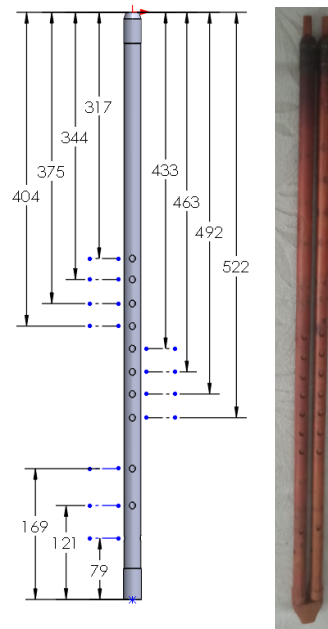
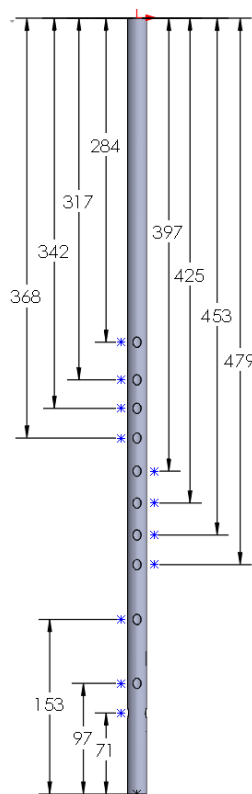


Figure 6. Photograph and organological schema of a kaval made by Trajko Korunosky, preserved in the Musical Instrument Museum, Phoenix, Arizona.

Maker: Velko Janjevic, 1937 Skopje, Macedonia (Kingdom of Yugoslavia).

In the Metropolitan Museum, New York. Item 1976.8.6a-c, procured in 1976 from the Crosby Brown Collection of Musical Instruments.



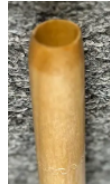
Length = 680 mm
 Outside diameter = 20 mm
 Bore diameter = 15 mm
 Thumbhole at 284 mm is bored from
 the back
 The hole at 153 mm is bored from the
 back
 Resonance holes at 71 mm are bored
 through both sides.

Figure 7. Organological schema and measurements of a chifte kaval made by Velko Janjevic, Skopje, Macedonia, 1937, preserved in the Metropolitan Museum of Art, New York.

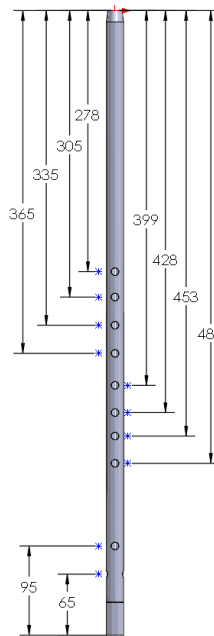
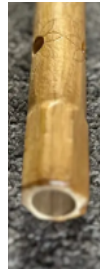
Kosovo Kavals by Shakir Hoti

Owned by Visar Munishi, Institute of Albanology in Prishtina. Department of Ethnomusicology

Length = 665 mm
Fingerholes are



bored thru both



8mm diam.
Hole at 278 mm is drilled from the back.
Bore is 15mm
Outside Diam. 18 mm
Holes at 65mm are bored thru both sides

Figure 8. Organological characteristics of a Kosovo kaval made by Shakir Hoti, including overall view, construction details, dimensions, bore diameter, and fingerhole arrangement.

Figure 9 is a map showing the towns of Gotse Delchev, Ablanitsa, Teplen and Beslen.



Figure 9. Geographic distribution of selected chifte kaval localities in the Gotse Delchev region of southwestern Bulgaria

Conclusion

Peter Brömse (1937:7) wrote “When I asked about the criteria used to determine the dimensions of the instruments, I received no explanation other than that the proportions are simply the way they have to be. The traditional dimensions are passed down from generation to generation without questioning.” Bromse wrote that no serious discussion of

intonation was possible given the method of spacing, which is determined simply by finger thickness (For a longer flute, the finger is pressed harder on the wood, creating a wider space between holes):

The finger holes are placed on the instrument tube at points where the fingers naturally fall during normal playing. This arrangement is based on the primal desire to make every tool—and a musical instrument is indeed a tool—as handy as possible in the truest sense of the word, i.e., to adapt it to the most comfortable grip of the hand. The pitches corresponding to such an arrangement are, in their relationship to one another, naturally completely irrational and different for each individual instrument. The structure of the scale is not in any way deliberate or intentional, since the instrument maker places the finger holes not according to specific intervals, but rather depending on the length and thickness of the fingers of the player for whom the instrument was built, i.e., on entirely "extramusical" factors. This resulting tonal order can be called the finger-hole tonal system "Griffonsystem". (Bromse 1937:97)⁵

It is not the case that all kaval sets selected here follow Bromse's description. Regarding one kaval set noted here, found in the Ethnographic Museum in Sofia, the distance between fingerholes from the thumb hole progressively down are: 25 mm, 28 mm, 30 mm, 30 mm, 32 mm, 33 mm, 30 mm. The general trend in this instrument is to space the holes progressively further apart. The Gotse Delchev kaval, as shown above, have a large gap between the hands. The finger spacing is quite precise: 25 mm, 27 mm, 27 mm, 38 mm, 27 mm, 27 mm, 28 mm.

Given the fingerspacing found in some instruments, I thought "What could be the reason for this, other than intonation?" but this I now believe, is a mistaken approach. Instead of the relationship of a kaval maker to the desired intonation, we see, for example in North Macedonia, rather a kinship intergenerational transmission of tacit knowledge in the traditional craft production of kaval which leads to a very conservative approach to change.

The Instrument labels in the Brussels Museum of Musical Instruments list their *chifte kaval* as "a type of (Turkish) *ney*". In various articles ethnomusicologists have thought of the kaval as having originated from the *ney*. The *ney* and the kaval differ greatly: differing fingerhole size, number and placement; different materials, the *ney* being made of cane (*Arundo donax*); differing bore geometry, the *ney* having a conical bore and a profound restriction at the node closest to the blowing edge. Unlike kaval, *neys* are sized according to key: various sizes are all built according to a schema of ratios that keep each instrument in tune with itself regardless of key. Besides this, the *ney* is used for playing Turkish classical music, while the kaval is a folk instrument. One would not expect to find the kaval in a Turkish classical music orchestra. Or so I thought. On my first visit to Istanbul (1986) to study *ney*, I was invited to sit in on a rehearsal of the Istanbul Radio Orchestra. Aside from a *ney* player, two kaval players were part of the orchestra! The kaval were playing extremely legato, with sweeping glissandos, with their notes floating above the orchestra. It was a sound I had always attributed to the *ney*. I learned it is best not to make generalizations from afar about the relationship of these end-blown flutes to one another other.

The *ney* is constructed such that, regardless of key, the thumbhole is always situated half the length of the instrument. The acoustical length of the kaval is far shorter than the length of the tube, since there are "resonator holes" below the bottom open hole (bored at the back) that determines the lowest note of the kaval. When taking note of the Brussels kaval we find exactly the same ratio as the *ney*: the distance from the blowing edge to the thumbhole is exactly one half the length of the blowing edge to the last unfingered open hole, bored at the back. But this is not true of other kaval measured for this article.

If Balkan kaval must have their origin in Turkey, it seems far more likely that they would have originated from Turkish kaval (perhaps played by *Yürök* shepherds imported into the Balkans) than from the Turkish *ney*, given the rigid social stratification of Ottoman society. Despina Mazaraki (p. 283) notes that the *Dzamara* (long end-blown kaval) found on the Island of Lesbos was introduced from Smyrna. She continues "One might suppose that those in Thrace were also introduced from Turkey."

At the time of writing, sadly, I have found only one name to associate with Bulgarian *chifte kaval* making. This is in contrast to makers in Kosovo and North Macedonia. Eliot Bates (2012) writes of "a seemingly outdated class on measuring and documenting physical objects" in describing dead organology classes. So why am I intent on this seemingly outdated activity? First, the kaval is not a violin: it can be reconstructed by any wood craftsman or machinist.

The wood - European ash - is not valuable, and can be substituted for nicely by American hard maple, with its tight grain. If this article can be a source of information to folks wishing to reconstruct these instruments, perhaps years from now, it will have served its purpose. But there is another reason, having to do with paying tribute to these Balkan craftsmen. This can best be described by an email I sent (in English and Bulgarian) to the mayor of Beslen, Bulgaria, a village seemingly noted for its chifte kaval making:

Dear Mayor Chapkanov,

I am writing from California to ask a favor: I am an independent researcher writing an article about chifte kavals from Bulgaria, Kosovo and North Macedonia.

Beslen kavals are found in museums in Brussels, St. Petersburg, Gotse Delchev, Serres, and Sofia. So the village of Beslen is famous for kaval making. But no one knows the family names of makers of these instruments. These craftsmen are lost to history. No one knows if there are people alive who have made these chifte kavals, or if people are still making them. Makers of chifte kavals in Kosovo and North Macedonia are known, and are written about in journals. I am trying to put the names of Beslen makers, living or not into a journal article about chifte kavals that will be published and available for years to come. I am asking for your help in this matter.

Mayor Chapkanov emailed me back 2/3/26 to say he will work on this for me as soon as possible.

Notes

1. There are two very fine concert flute makers in The U.S.: Haynes and Powell. Both are situated in Cambridge, Mass. Why is this? Because there exists a “society of expertise” in Cambridge, as in Silicon Valley. This kind of society of sorts may have existed in Beslen and surrounding villages.

2. Information Concerning the chifte kavals in the Brussels Museum of Musical Instruments was published by Victor-Charles Mahillon in 1893:1922 Catalogue descriptive et analytique du Musée instrumental (historical et technique du Conservatoire royal de musique de Bruxelles:

3. Item 2400 Double Kaval:

Both flutes belong to the ney type and are used among the nomadic Koudso-Vlach Population. They are simple cylindrical wooden pipes, pierced with nine lateral holes, the first of which is not covered by the fingers, and below these, three other holes whose opening serves only to adjust the intonation produced by the first lateral hole. The intonations obtained by the lateral holes in use are as follows: F, G, A, B flat, B, C, D, E, F

4. The Saracatsani are a semi-nomadic Greek-speaking herding people. Before borders were established they were transhumant, travelling throughout the southern Balkans with their flocks. Patric Leigh Fermor, in his book Roumeli (p.55) mentions that the Saracatsani had two kinds of flutes. “One is a sawed-off gun barrel into which holes have been bored at appropriate intervals....”

5. Regardless of Brömse’s consideration of an irrational fingering system, there is a way of checking whether the kaval is in tune with itself. The kaval is usually played at the first overtone, the fundamental sounding very soft. The second overtone raises the notes another 5th. The kaval has two “enharmonic equivalents”: different fingerings playing the same note. (The pitch is the same but the timbre is very different). The note played with all fingers down except the bottom finger, and overblown (2nd overtone) to raise it a fifth, should sound the same note as that played with the thumb raised. If this is not the same, the scaling of the instrument is incorrect, or at least, the thumb hole location is not correct. Similarly, if the kaval is played with all fingers down, and overblown a fifth, it should sound the same note as that sounded with only the thumb and 1st fingerhole covered. Enharmonic fingerings play an especially important role in playing both kaval and Turkish ney. Semsettin Alanc and Sinan Duru (p.133) demonstrate that ney player/composer, Neyzen Emin Dede (1883-1945) has written ney exercises with marks showing which position (“closed” or “open”) of enharmonic fingering should be used when playing a particular melody.

Acknowledgements

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Bulgaria; Visar Munishi at the Institute for Albanology, Prishtina, Kosovo. Thank you to Stefche Stojkoski for providing information and photos re. Korunosky kavals. I am indebted to Professor Peter Brömse for giving me verbal permission to use his materials for further research and display.

Biodata of Author



Dr. **Anthony Tammer** is a retired educator, researcher, craftsman, and ethnomusicologist whose professional and scholarly work spans industrial education, occupational safety, precision metalworking, and the traditional musical cultures of the Balkans and Türkiye. His interest in Balkan folk music and Turkish classical music began during an academic exchange year in Yugoslav Macedonia in 1976, where he learned to play the Macedonian kaval. Upon returning to the United States, he performed Macedonian folk music with a Bay Area ensemble and was subsequently introduced to the Turkish ney by a student of the renowned ney master Aka Gündüz Kutbay. Dr. Tammer pursued ney studies for seven years before traveling to Istanbul to continue his training under Fuat Türkelman. This experience led to the publication of his article, *Constructing the Turkish Ney* (1992), published in *Turkish Music Quarterly*. In 1996, twenty years after his initial stay in Macedonia, Dr. Tammer returned to revisit the family of a respected kaval maker. Spending a day documenting the instrument-making process through photographs and observation, he gathered material that formed the basis of his publication *Kavals and Zamares: End-blown Flutes of Greece and Macedonia* (1998), published through the University of Maryland's *Ethnomusicology Online*. His fieldwork also included research in Greece, where he studied the floghera (short end-blown flute) with musician Aristides Vasillaris. In addition to documenting traditional instruments, he has spent many years constructing kavals and flogheras and continues to pursue research on Balkan wind instruments, including his current work on çift kavals. In 1994, Dr. Tammer spent seven months in Ankara working with the Turkish Ministry of Vocational Education (Mesleki Eğitim Bakanlığı). During this appointment, he conducted research on Turkish vocational education practices, resulting in the conference paper *Evaluation of Curriculum Development Research* (1994), presented at a conference organized by the Center for Occupational Research and Development. While in Ankara, he also studied Turkish Classical Music with the ensemble led by Polat Kale, son of Emin Kılıç Kale. Through this experience, he became acquainted with the musical philosophy of Emin Kılıç Kale and developed a lasting appreciation for the traditions of Turkish classical music and the hospitality of the Kale family and their associates. Professionally, Dr. Tammer's career has focused on precision metalworking, industrial education, and occupational safety. He was awarded a Regents Fellowship to pursue doctoral studies in Industrial Education at Texas A&M University, where he completed his PhD in 1994. His research contributed to the publication of *Teaching Welding Safety in Texas Community Colleges* (1997) in *New Solutions: A Journal of Environmental and Occupational Health Policy*, published by the Oil, Chemical and Atomic Workers Industrial Union. For more than twenty-five years, Dr. Tammer taught precision metalworking at several California Community Colleges and at a four-year high school. In recognition of his excellence in teaching and grant-writing activities, he received a \$10,000 Eukel Trust Award. Now retired, Dr. Tammer continues his scholarly and practical engagement with traditional musical instruments and instrument-making, dedicating his time to completing his research and writing on çift kavals. At the age of eighty-one, he remains active in the preservation, study, and documentation of traditional musical craftsmanship and performance practices in the Balkans and Türkiye.

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A few YouTube performances with chifte kaval

- Makedonier: (11/11/2008) Stefche Stojkovski on Gaida, kavals made by Trajko Korunoski https://www.youtube.com/watch?v=qrDquNa3ki8&list=RDqrDquNa3ki8&start_radio=1
- Salla Shabani1545: (10/13/2020) Salla Shabani and friend performing an ezgia (improvisation) https://www.youtube.com/watch?v=B_cAqhnjYpE&list=RDB_cAqhnjYpE&start_radio=1
- Instrumenti 1 Shaqir Hoti (approx.. 2011) Kosovo kaval maker. Listen to the tone! <https://www.youtube.com/watch?v=Lbmt6hhpq3s&list=RDLbmt6hhpq3s&index=1&pp=8AUB>
- Two ethnic Albanian kaval players from North Macedonia
- TV Topestrada Tetove (2017) Tetova, North Macedonia Shevket Ismani, Shevket Latifi; https://www.youtube.com/watch?v=9Vra89GsYhE&list=RD9Vra89GsYhE&start_radio=1

Research Article

An organological study and reconstruction of the Azerbaijani Ergon based on Abd al-Qadir al-Maraghi's descriptions

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Reconstruction

Abstract

This study examines the Azerbaijani Ergon from an organological perspective by investigating its historical development, etymology, place in classical Azerbaijani literature, and morphological characteristics based on the descriptions of Abd al-Qadir al-Maraghi, and presents the first practical attempt at its reconstruction. A document analysis method was employed. The study comparatively analyzed Abd al-Qadir al-Maraghi's musical treatises together with the works of Abbasgulu Najafzade, Saadet Abdullayeva, and Efrasiyab Badalbeyli, as well as classical Azerbaijani poetry and the international organological literature. The findings indicate that the Azerbaijani Ergon is a keyboard aerophone equipped with a bellows-driven air supply system, pipes of varying lengths, and a button-operated sound control mechanism. Furthermore, classical literary sources demonstrate that the instrument occupied a significant place in the musical culture of medieval Azerbaijan. Based on the historical evidence, the morphological characteristics of the Azerbaijani Ergon were reinterpreted, and the first physical prototype of the instrument was developed through the collaboration of Teymur Huseynov, a master craftsman of wind instruments at the Azerbaijan National Conservatory, and the author of this study, Enver Sadikov, using the technical drawing prepared under the supervision of Abbasgulu Najafzade as the principal reference. In conclusion, this study not only clarifies the historical and organological characteristics of the Azerbaijani Ergon but also presents the first applied reconstruction model of this forgotten instrument, thereby making an original contribution to the fields of Azerbaijani music history and organology.

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Introduction

The Azerbaijani Ergon is regarded not only as a historical musical instrument belonging to Azerbaijani musical culture but also as an important link in the development of keyboard aerophones from Antiquity to the Middle Ages. The origins of this instrument, which is widely recognized as a historical precursor of the modern European organ, can be traced back to the hydraulis, the hydraulic organ developed within the engineering tradition of Ancient Greece. In the organological literature, the hydraulis is considered not only one of the earliest keyboard instruments but also one of the first complex aerophone systems to employ controlled air pressure for sound production (Williams, 1993; Perrot, 1971).

According to historical sources, the hydraulis was developed by the engineer Ctesibius in Alexandria during the third century BCE. Ctesibius's most significant innovation was the stabilization of airflow through the use of water pressure, thereby enabling pipes of different lengths to produce a continuous and stable sound. In subsequent centuries, although the hydraulic mechanism was gradually replaced by pneumatic bellows systems, the fundamental operating principle

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remained unchanged. Consequently, many scholars acknowledge a technological continuity between the medieval European organ and the ergan (erganun) known in the Islamic world (Williams, 1993; Montagu, 2007).

According to the renowned Azerbaijani composer, conductor, and musicologist Efrasiyab Badalbeyli (1907-1976), the erganun (more accurately, the ergan) was invented around 300 BCE by the Greek engineer and inventor Ctesibius (285-222 BCE) in Alexandria, Egypt (Badalbeyli, 2017, p. 72). Although Badalbeyli recorded the inventor's name as "Ktezibey," it also appears in various sources as "Ktesibiy," "Ktebizey," or "Ktebizius." Nevertheless, the historically accepted form of the inventor's name is Ctesibius.

From an organological perspective, the ergan belongs to the category of keyboard aerophones in the Hornbostel-Sachs classification, in which sound is produced by the vibration of a free air column within pipes. Since sound production depends directly on air pressure, the instrument's acoustic characteristics are determined primarily by the length and diameter of the pipes and the regulation of airflow. For this reason, historical descriptions of the ergan emphasize not only the number of pipes but also its bellows system, air channels, and sound-control mechanism. Modern organological research further emphasizes that the reconstruction of a historical musical instrument cannot rely solely on written descriptions; rather, technical accounts, iconographic evidence, and surviving comparable instruments must be evaluated together (Kartomi, 1990; Montagu, 2007).

Information concerning ergan-like instruments in the Islamic world has survived primarily through musical treatises, travel accounts, and literary works. Among these sources, the detailed technical descriptions provided by Abd al-Qadir al-Maraghi are particularly significant. His account not only records the name of the instrument but also provides valuable information concerning the arrangement of its pipes, bellows system, key mechanism, and performance technique, thereby offering sufficient detail for organological interpretation. Accordingly, Maraghi's descriptions constitute one of the most important historical sources for reconstructing the Azerbaijani Ergan.

From the time of its invention, the ergan spread throughout various regions of the East. Literary evidence, particularly the poetry of Qatran Tabrizi (Maragali, 1977, p. 239), suggests that the instrument had reached Azerbaijan by no later than the eleventh century. Although literary sources do not provide detailed technical descriptions of the ergan or erganun, they clearly indicate that it belonged to the aerophone family. Unfortunately, like many historical musical instruments, the Azerbaijani Ergan has not survived to the present day. In later centuries, the European organ evolved on the basis of the instrument originally developed by Ctesibius.

The term *organ*, which came into use in Europe from approximately the tenth century onward (Dolzansky, 1964, pp. 235-237), derives from the Greek *organon* and the Latin *organum*. These words originally meant "instrument" or "tool" and, figuratively, "the musician's instrument." In this context, the latter expression should be understood metaphorically rather than literally. It is also noteworthy that in Persian the word *erganun* is likewise used to denote the organ (Abdullayev et al., 2005, p. 71).

Regarding the etymology of the term, Najafzade writes:

"Essentially, *erganun* is the plural form of the Persian word *ergan*. Therefore, it may also refer simply to *ergan*. The Persians most likely adopted the plural form *erganun* because of the instrument's numerous pipes" (Najafzade, 2022, p. 70).

The famous Ottoman traveler and scholar Evliya Çelebi ibn Derviş Mehmed Zillî (1611-1682) also referred to an aerophone called the *erganun borusu* ("erganun pipe") in his writings (Farmer, 1999, p. 42). This expression clearly indicates an instrument consisting of multiple pipes, corresponding to the structural characteristics of the ergan.

In contemporary organological research, the reconstruction of a historical musical instrument is not undertaken through the direct application of a single written source. Instead, the experimental organology approach requires the combined evaluation of historical texts, philological analyses, iconographic evidence, comparable instruments, and acoustical data. Such an approach enables the resulting prototype to remain as faithful as possible to the historical evidence while also meeting scientific standards of reconstruction. In recent decades, this methodology has been widely

employed in the reconstruction of historical instruments such as early organs, the *aulos*, the lyre, and other ancient musical instruments.

Research Aim and Problem

The Azerbaijani Ergän, which is recognized as an important component of Azerbaijan's musical heritage, is one of the historical musical instruments frequently mentioned in historical documents and classical literary works but for which no physical specimen has survived to the present day. Consequently, knowledge concerning its structural characteristics, operating system, sound-production mechanism, and organological classification has remained limited. Previous studies have largely been confined to historical descriptions, while practical reconstruction attempts have received little scholarly attention. In particular, the detailed descriptions provided by Abd al-Qadir al-Maraghi require re-evaluation within the framework of modern organological approaches and comparative examination alongside other historical sources.

The primary aim of this study is to examine the historical development, etymology, literary representations, and morphological characteristics of the Azerbaijani Ergän from an organological perspective by drawing upon Abd al-Qadir al-Maraghi's descriptions, historical musical treatises, classical Azerbaijani literature, and the modern organological literature. Based on the evidence obtained, the study also seeks to develop a scientific reconstruction model for the Azerbaijani Ergän and to contribute to the revival of this forgotten historical instrument through the development of its first physical prototype.

Method

This study is qualitative in nature and is grounded in the historical organology approach. Document analysis was employed as the principal research method. Document analysis is a qualitative research method involving the systematic examination, comparison, and interpretation of written and visual materials relevant to the phenomenon under investigation (Bowen, 2009; Merriam & Tisdell, 2016).

The research began with an examination of the musical treatises of Abd al-Qadir al-Maraghi, followed by a comparative analysis of the organological studies of Abbasgulu Najafzade, Saadet Abdullayeva, and Efrasiyab Badalbeyli. In addition, the works of Qatran Tabrizi, Khaqani Shirvani, Nizami Ganjavi, and Muhammad Fuzuli were analyzed to identify references to the Azerbaijani Ergän in classical Azerbaijani literature. Furthermore, the findings were interpreted within an organological framework through comparison with the international literature on historical musical instrument reconstruction.

During the practical stage of the research, a technical drawing of the Azerbaijani Ergän was first prepared by Seyran Bedeloglu, a member of the Azerbaijan Artists' Union, on the basis of the historical evidence collected. Using this drawing as the principal reference, the first physical prototype of the Azerbaijani Ergän was subsequently constructed through the collaboration of Teymur Huseynov, a master craftsman, performer, and repair specialist of wind instruments at the Azerbaijan National Conservatory, and the researcher Enver Sadikov. This process enabled the organological evidence derived from historical sources to be translated into practice through an experimental reconstruction of the instrument.



Photo 1. Exterior view of the Azerbaijan National Conservatory (left) and President Ilham Aliyev inspecting the Conservatory during the opening ceremony (right) (Web 1).

The Azerbaijan National Conservatory is a higher education institution dedicated to the preservation, development, and scientific study of Azerbaijan's traditional musical culture. The Conservatory carries out research on historical

musical instruments through specialized laboratories and supports projects focusing on their documentation, reconstruction, and reproduction. Owing to its research facilities and expertise in traditional musical instruments, the Conservatory provides an appropriate scientific environment for applied studies on the reconstruction of historical instruments.

Results

The Azerbaijani Ergän

Historical evidence indicates that during the medieval period, two distinct types of the Azerbaijani Ergän were used in Azerbaijani musical culture, differing in both their structural characteristics and sound-production mechanisms. One belonged to the aerophone family, in which sound was produced by means of an air stream, whereas the other was classified as a chordophone, producing sound through vibrating strings. Furthermore, the aerophone Ergän itself existed in two different forms according to its operating principle: pneumatic and hydraulic. Historical sources suggest that the pneumatic type was considerably more widespread throughout Azerbaijan.

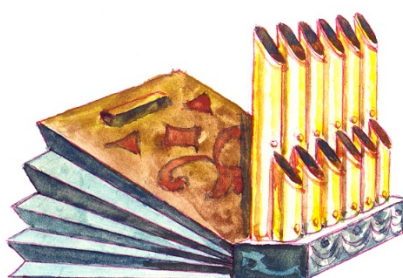


Figure 1. Drawing of the Azerbaijani Ergän (Illustration by Seyran Bedelöglü)

The most comprehensive information concerning the Azerbaijani Ergän is found in the works of Professor Abbasgulu Najafzade, Doctor of Arts (Najafzade, 2004a, pp. 217-224; 2004b, p. 86; 2004c, pp. 44-45; 2016, pp. 243-257; 2018, pp. 237-240; 2022a, pp. 66-71; 2022b, pp. 225-233). Consequently, his studies constituted one of the principal sources consulted throughout the present research. However, because the Azerbaijani Ergän has not yet been fully reconstructed, it is not currently possible to determine with certainty its pitch range, tuning system, timbral characteristics, or several other organological properties. For this reason, the present study aims to reconstruct the Azerbaijani Ergän on the basis of available historical evidence. Accordingly, the first stage of the reconstruction project was initiated at the Azerbaijan National Conservatory in collaboration with Teymur Huseynov, a master craftsman, performer, and repair specialist of wind instruments.

Although the detailed descriptions provided by Abd al-Qadir al-Maraghi constitute the primary historical source for this study, they have been evaluated together with evidence concerning the instrument's historical origins, etymological development, references in classical Azerbaijani literature, and findings from the modern organological literature. On the basis of these complementary sources, the probable structural characteristics of the Azerbaijani Ergän have been reinterpreted. Consequently, this study extends beyond the presentation of historical information by proposing an organological model for the scientific reconstruction of a forgotten historical musical instrument.

Literary References to the Azerbaijani Ergän

In historical organological research, literary texts are regarded as important indirect sources for identifying the existence, functions, and cultural significance of musical instruments whose physical examples have not survived to the present day. Although poems and other literary works rarely provide detailed technical descriptions of musical instruments, they offer valuable information regarding the social contexts in which such instruments were used, the other instruments with which they were associated, and their symbolic position within musical culture. Therefore, when evaluated together with written musical treatises, iconographic evidence, and historical records, classical literary texts provide important complementary data for organological research (Kartomi, 1990; Libin, 2018).

The classical Azerbaijani poets Qatran Tabrizi (1012-1088), Khāqānī Shirvānī (1120-1199), Nizami Ganjavi (1141-1209), and Muhammad Fuzuli (1494-1556) all referred to the Azerbaijani Ergän in their poetry.

Qatran Tabrizi describes the Erganun and the drum as instruments that inspired warriors on the battlefield:

*On the day of battle, when you mounted your horse,
The sound of the drum and the sound of the Erganun accompanied you together* (Qatran Tabrizi, 1967, p. 239).

This verse suggests that during Qatran Tabrizi's lifetime, the Ergan was also used as an instrument to encourage soldiers before battle. As noted earlier, alongside the aerophone Ergan, Azerbaijani musical culture also included a chordophone instrument bearing the same name. In our opinion, the poet refers here to the aerophone Ergan, since medieval military ensembles primarily employed aerophones and membranophones. Moreover, Qatran Tabrizi equates the sonic power of the Erganun with that of the drum, indicating its prominent role in military music.

Khāqānī Shirvānī likewise mentions the Ergan together with various musical instruments:

*Is it the voice of Barbad, or the sound of the saz and the mizmar?
Is it the setar, or the resounding kasegar and the Ergan?* (Khaqani Shirvani, 2004, p. 415).

In this verse, Khāqānī compares the voice of the celebrated court musician Barbad with the sounds of the saz, the three-stringed setar, the wind instrument mizmar, the idiophonic kasegar, and the bellows-operated keyboard instrument known as the Ergan.

In another poem, Khāqānī writes:

*I wish to cast away the harp of sorrow from my breast;
My throat has become an Ergan, crying out in lament* (Khaqani Shirvani, 2004, p. 269).

Nizami Ganjavi also refers to the Ergan (Erganun) in his *Layla and Majnun*:

سازنده ارغنون این ساز
از پرده چنین برآرد آواز

The verse may be transliterated as follows:

*Sāzende-ye arghanūn-e īn sāz
Az parde chenīn bar ārad āvāz.*

An English translation of the couplet is:

*The performer of this Erganun instrument
Brings forth such a melody from its tones.*

Professor of Philology Mübariz Alizade (1911-1994), in his Azerbaijani translation, rendered the word *Erganun* as "organ" in parentheses:

*The one who plays the Erganun (organ) of this instrument,
Produces such a melody from its tones* (Bardakci, 1986, p. 162).

From an organological perspective, however, the use of the term *Ergan* rather than *organ* appears to be more appropriate, since the Azerbaijani Ergan is regarded as the historical predecessor of the modern European organ rather than the same instrument in its present form.

Muhammad Fuzuli likewise refers to the Ergan in his poetry:

*The Ergan reached the heavens,
Its sigh set the whole world aflame* (Muhammad Fuzuli, 2005, p. 72).

The repeated references to the Azerbaijani Ergan by poets from the eleventh to the sixteenth centuries indicate that the instrument was not merely a literary image but also a well-known component of the musical culture of its time. Qatran Tabrizi associated the Ergan with military music, Khāqānī employed it in the context of court music and poetic imagery, Nizami connected it with musical performance, and Fuzuli used it as a powerful metaphor. Collectively, these literary references demonstrate that the Azerbaijani Ergan occupied diverse social and artistic functions within medieval Azerbaijani culture. In organological research, literary sources of this kind are regarded as valuable supplementary

evidence for tracing the historical circulation and cultural visibility of musical instruments whose physical examples have not survived (Kartomi, 1990; Libin, 2018).

Morphology and Reconstruction of the Azerbaijani Ergan

The aerophone Azerbaijani Ergan is regarded as one of the earliest keyboard instruments equipped with a bellows system known to have been used in Azerbaijan. The earliest reference to the Azerbaijani Ergan appears in the musical treatises of the eminent musicologist and scholar Abd al-Qadir al-Maraghi (1353-1435). Our knowledge of al-Maraghi's descriptions of the Ergan is derived primarily from the Persian translation prepared by the distinguished scholar and philologist Mammadali Musaddiq (1925-1997). Musaddiq translated the relevant passage as follows:

"The Erganun is an instrument widely used by Europeans, the Franks (until the end of the nineteenth century, Europeans were commonly referred to as 'Franks' in Iran, according to Musaddiq). In this instrument, the reeds are arranged side by side in a row. The reeds are made of tin. Those producing lower pitches are longer and placed at the upper part, whereas the shorter ones producing higher pitches are positioned below. On the left side of the instrument, at the back, there is a mechanism similar to the air-supplying section of a blacksmith's bellows. Air is distributed from this mechanism to all the reeds. The bellows are operated with the left hand, while the fingertips of the right hand produce the melody. On one side there are circular buttons, about the size of a chickpea, positioned over the openings. When these buttons are pressed, the openings are uncovered and sound is produced" (Maragali, 1977, p. 77).

Unlike the earlier literary references that merely mention the name of the instrument, Abd al-Qadir al-Maraghi's description provides detailed information concerning its structural characteristics. From an organological perspective, this account demonstrates that the Azerbaijani Ergan was an aerophone in which sound was produced by an air stream, featuring pipes of varying lengths, a bellows-driven air supply system, and a button-operated sound-control mechanism. Consequently, Maraghi's description may be regarded as one of the most comprehensive historical organological sources available for reconstructing the Azerbaijani Ergan (Kartomi, 1990; Montagu, 2007).

In this passage, the word *ney* clearly refers to pipes rather than the end-blown flute known by the same name. Accordingly, Maraghi described the Ergan as a button-operated, bellows-driven wind instrument belonging to the aerophone family.

Professor Saadet Abdullayeva (1940-2017), widely regarded as the founder of modern Azerbaijani organology, refers to this instrument as the *Ergan* rather than the *Erganun* in Azerbaijani:

"According to Abd al-Qadir al-Maraghi, the Ergan (Erganun in the original text) was used primarily by Europeans" (Abdullayeva, 2002, p. 30).

Accordingly, both Saadet Abdullayeva and Abbasgulu Najafzade argue that the word *Erganun* appearing in Abd al-Qadir al-Maraghi's treatise should be understood as referring to the Azerbaijani Ergan.

Al-Maraghi's description of the Erganun was also translated into Turkish by Murat Bardakçı:

"It was used by the Franks and consisted of interconnected metal pipes. At the back were bellows through which air was supplied to the reeds. The bellows were operated with the left hand, while the right hand controlled the reeds intended to produce sound" (Farmer, 1999, p. 108).

Compared with Musaddiq's translation, Bardakçı's version exhibits certain differences in terminology. Nevertheless, from an organological perspective, both translations are largely consistent. They describe the Azerbaijani Ergan as an instrument equipped with a bellows-driven air system, pipes of varying lengths, and a manually controlled sound-producing mechanism. The differences relate primarily to terminology and the interpretation of certain structural details rather than to the instrument itself. This indicates that although the wording of the translations differs, Maraghi's original description consistently refers to the same organological type. Bardakçı's translation also interprets the Erganun as an early form of the organ and notes that its pipes were originally made of reed.

Abbasgulu Najafzade likewise states that the earliest pipes of the Azerbaijani Ergan were made of reed:

"When Ktezibey (Ctesibius) constructed the first Ergan, he used reed pipes. For this reason, the expression 'reed Ergan' also emerged. In later periods, these pipes were manufactured from bronze, brass, and other metals" (Najafzade, 2022, p. 70).

The transition from reed pipes to metal pipes should not be regarded merely as a change of material. Organological research has demonstrated that the material of the pipes directly influences an instrument's resonance, sound intensity, durability, and tuning stability (Montagu, 2007; Perrot, 1971). Consequently, Najafzade's observations are important because they indicate that the Azerbaijani Ergan underwent a significant technological evolution throughout its historical development.

Efrasiyab Badalbeyli likewise provides a brief yet important description of the structure of the Azerbaijani Ergan:

"The Erganun consists of pipes of different sizes arranged side by side and a special pneumatic system that supplies air to these pipes by means of bellows" (Badalbeyli, 2017, p. 72).

Badalbeyli's description supports the account provided by Abd al-Qadir al-Maraghi. Both scholars describe the fundamental operating principle of the instrument as the controlled delivery of air into a series of pipes. This evidence further supports the conclusion that the Azerbaijani Ergan was a pneumatic aerophone rather than a hydraulic organ. It should also be noted that the term *pneumatic* is derived from the Greek word *pneuma*, meaning "air" or "breath," and refers to systems operated by compressed air.

Whereas Badalbeyli refers to the instrument as having "bellows" in the plural, Saadet Abdullayeva states that the Azerbaijani Ergan was equipped with a single bellows:

"Behind the pipes there was a bellows that supplied air. The bellows was compressed with the left hand, while the large buttons located beside the pipes were pressed with the right hand. In this way, the airflow was released, producing sounds of different pitches" (Abdullayeva, 2002, p. 30).

When the available historical sources are evaluated collectively, several organological characteristics of the Azerbaijani Ergan can be identified with a high degree of confidence. These include a bellows-driven air supply system, pipes of varying lengths, a button-operated sound-control mechanism, and a manually operated airflow system. However, important details such as the exact number of pipes, pitch range, tuning system, construction materials, and timbral characteristics remain unknown because of the limited historical evidence. Consequently, the reconstruction presented in this study should be regarded as a scientifically informed model based on historical documentation rather than a definitive reconstruction of the original instrument.

On the basis of classical literary sources, particularly the descriptions provided by Abd al-Qadir al-Maraghi, the Azerbaijani Ergan appears to have been a pneumatic instrument possessing characteristics distinct from those of the hydraulic organ. At the same time, its structural similarities to instruments such as the *tulum*, *musikar*, and *cipçik* do not constitute evidence of a direct historical relationship but rather indicate possible organological and technical parallels. Therefore, these similarities should be interpreted not as proof of common origin but as comparative organological evidence capable of contributing to the reconstruction process (Kartomi, 1990; Montagu, 2007).

Based on the historical evidence collected during his research, Abbasgulu Najafzade commissioned Seyran Bedeloglu, a member of the Azerbaijan Artists' Union, to prepare the first technical drawing of the Azerbaijani Ergan (see Figure 2). Using this drawing as the principal reference, reconstruction work on the instrument was initiated in collaboration with Teymur Huseynov, a wind-instrument performer, craftsman, and specialist at the Azerbaijan National Conservatory (see Photo 2). The project aims to restore to musical life an instrument that was originally invented approximately 2,300 years ago.

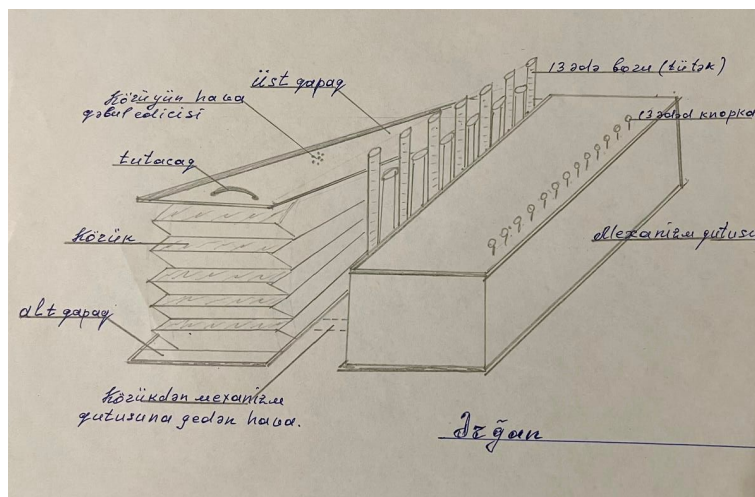


Figure 2. Technical drawing of the Azerbaijani Ergon based on historical sources (Drawing by Seyran Bedelolu; author's personal archive).



Photo 2. Prototype of the Azerbaijani Ergon developed by Enver Sadıkov and Teymur Hüseynov at the Azerbaijan National Conservatory on the basis of Abd al-Qadir al-Maraghi's descriptions and historical organological sources (Author's personal archive).

The prototype shown in Figure 3 was developed through a comprehensive analysis of the organological descriptions provided by Abd al-Qadir al-Maraghi, the studies of Abbasgulu Najafzade, and other historical sources. The reconstruction process was carried out collaboratively by Teymur Hüseynov, a wind-instrument craftsman, performer, and repair specialist at the Azerbaijan National Conservatory, and the author of this study, Enver Sadıkov. During the initial stage, a technical drawing of the Azerbaijani Ergon was prepared on the basis of the available historical evidence, and this drawing subsequently served as the basis for constructing the first physical prototype of the instrument. The prototype incorporates the principal structural characteristics described in the historical sources, including a bellows-operated air supply system, pipes of varying lengths, and a button-operated sound-control mechanism. It should therefore be regarded as an experimental organological reconstruction model that provides a scientific basis for future acoustic analyses, performance studies, and further refinement.

Conclusion and Recommendations

This study examined the historical development, etymology, literary representations, and morphological characteristics of the Azerbaijani Ergon from an organological perspective based primarily on the descriptions of Abd al-Qadir al-Maraghi. Maraghi's musical treatises were used as the principal historical source and were comparatively evaluated alongside the studies of Abbasgulu Najafzade, Saadet Abdullayeva, and Efrasiyab Badalbeyli, as well as classical literary

sources and the modern organological literature. On the basis of these analyses, the structural characteristics of the Azerbaijani Ergan were reinterpreted, and new organological insights into its historical development were presented.

The principal outcome of the study is the preparation of the first reconstruction design of the Azerbaijani Ergan and the development of its first physical prototype through the collaboration of Teymur Huseynov, a wind-instrument craftsman at the Azerbaijan National Conservatory, and the author of this study, Enver Sadikov. Developed entirely on the basis of historical and organological evidence, this prototype represents an experimental reconstruction model that provides a scientific foundation for future studies.

From a practical perspective, further acoustic measurements, performance experiments, and structural improvements of the prototype are recommended. The reconstructed Azerbaijani Ergan may also be introduced through educational activities, concert performances, museum exhibitions, and cultural heritage projects, thereby contributing to the revival of a forgotten historical musical instrument. Future research should incorporate additional historical musical treatises, iconographic evidence, archaeological findings, and interdisciplinary analytical methods in order to refine the reconstruction and further clarify the organological characteristics of the Azerbaijani Ergan. Such studies are expected to contribute significantly to the preservation of Azerbaijan's historical musical heritage and to the advancement of international organological research.

Biodata of Author



Assoc. Prof. Dr. **Enver Sadikov** (born April 30, 1966, Baku, Azerbaijan SSR) is an Azerbaijani musician and garmon performer. He was awarded the title of People's Artist of the Republic of Azerbaijan in 2014 and serves as the Artistic Director of the *Qaytağı* Instrumental Ensemble. A distinguished master musician, Sadikov performs in a wide range of musical genres, including Azerbaijani folk music, mugham, classical music, and jazz, successfully creating a unique synthesis and artistic bridge between these traditions. Sadikov began his professional stage career in 1990 at the Rashid Behbudov State Song

Theatre. From 1994 to 2006, he worked as a musician and arranger in the ensemble of the People's Artist Brilliant Dadashova. In 2000, he founded the *Qaytağı* Instrumental Ensemble, of which he remains the artistic director. Since 2012, the ensemble, featuring Honored Artist Abbas Baghirov as its soloist, has been affiliated with Azerbaijan State Television and Radio. Throughout his career, Sadikov has performed in numerous countries, including Norway, the United Kingdom, Russia, the United States, Israel, Cyprus, France, Austria, Italy, Germany, Belgium, Türkiye, Ukraine, Morocco, Georgia, and China. He has also represented Azerbaijani music at numerous cultural events and concerts organized by the Heydar Aliyev Foundation, UNESCO, and ICESCO. Among his notable international engagements are the Azerbaijan-Norway project *Landet vi kommer fra* with Norway's Skruk Choir (1996-1997); concerts at the Rossiya Concert Hall in Moscow (1998), Washington, D.C. (1999), and New York (2000); performances at UNESCO Headquarters in Paris dedicated to the 100th anniversary of Academician Yusif Mammadaliyev (2005), the concert *At the Crossroads of Cultures and Civilizations* (2006), the centenary of Mir Jalal Pashayev (2008), and the *Young Talents of Azerbaijan* concert (2011). Other significant appearances include the Nar Festival in Vienna (2011), a series of concerts celebrating the 20th anniversary of the independence of the Republic of Azerbaijan across France, Italy, Germany, Türkiye, and other countries (2011), the opening of the Azerbaijan Cultural Center in Vienna (2013), a solo concert at the *Azerbaijan Village* organized by the Heydar Aliyev Foundation in Paris (2014), promotional concerts abroad dedicated to the First European Games held in Azerbaijan (2015), a jazz concert in Cannes (2015), the Athens Technopolis Jazz Festival (2017), a solo concert at the Grand Pera Emek Stage in Istanbul (2018), a concert in Riga (2018), and the Azerbaijan-China Friendship Concert at the National Centre for the Performing Arts in Beijing (2018), in addition to numerous other international projects and performances. In recognition of his artistic achievements, Sadikov received the Zirve Award of the Azerbaijan Democratic Student Youth Organization in 2001 and the Humay Award of the *Bakılı* International Cultural Society in 2006. Since 1999, he has released several albums, including *Take Five*, *Selections 2000-2010*, *Selections 2010-2015*, and *Impressions*. His music videos, including *Take Five*, *Tango*, *Güllərim*, *Libertango*, and *Waltz*, were released between 1997 and 2008. Throughout his artistic career, he has developed a distinctive performance style and established his own musical language in Azerbaijani garmon performance. To further his education, Sadikov enrolled in the Faculty of Music at Azerbaijan State Pedagogical University in 2006. After graduating, he continued his studies at the Faculty of Folk Musical Instruments of the Azerbaijan National Conservatory between 2015 and 2017, where he earned his master's degree. Since 2017, he has served as a faculty member at the

Conservatory, and since 2019 he has been a Senior Lecturer in the Department of Instrumental Mugham, teaching the specialization course in Azerbaijani Garmon and Mugham. Beginning in 2001, Sadikov pursued his long-held ambition of developing a new Azerbaijani garmon by conducting extensive experimental work. In 2007, he successfully created the three-octave ReneveR garmon featuring a new register system. The instrument was officially recognized by the Copyright Agency of the Republic of Azerbaijan in 2013 and was subsequently registered and patented as an invention by the Intellectual Property Agency of the Republic of Azerbaijan in 2018. Owing to its expanded tonal range and additional register, this innovative instrument has introduced new performance possibilities for Azerbaijani garmon players and has gained widespread popularity among younger performers. Among Sadikov's most acclaimed performances was his two-day solo concert entitled *Impressions*, held at the International Mugham Center in Baku in 2016. In 2017, he presented the same concert program at the Heydar Aliyev Congress Center in Gabala. He also participated in the centenary concert of the eminent Azerbaijani composer Tofig Guliyev at the Heydar Aliyev Center in 2017 and performed at the 10th Gabala International Music Festival in 2018. Together with the *Qaytağı* Instrumental Ensemble, Sadikov continues to perform regularly both throughout Azerbaijan and internationally, participating in cultural events, artistic evenings, and concert programs, including anniversary concerts of Azerbaijan State Television and Radio as well as tribute concerts dedicated to prominent Azerbaijani composers such as Arif Melikov, Tofig Guliyev, Rauf Hajiyev, Ramiz Mirişli, Emin Sabitoglu, Elza Ibrahimova, and Mobil Babayev. Sadikov's artistic achievements have been highly recognized by the Republic of Azerbaijan. In 2007, he was awarded the honorary title of Honored Artist of the Republic of Azerbaijan, and in 2014 he received the country's highest artistic distinction, the title of People's Artist of the Republic of Azerbaijan.

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Research Article

Technical standards in the construction and repair of the Azerbaijani kamancha: An organological study

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Article Info	Abstract
Submitted: 11 October 2025 Accepted: 26 December 2025 Online: 20 March 2025 Keywords Azerbaijani kamancha Musical instruments Instrument selection Recognition of instruments Organology 3023-7890/ © 2026 JTO Published by Genç Bilge (Young Wise) Pub.Ltd. This is an open access article under the CC BY-NC-ND license. 	This study presents a systematic organological examination of the professional Azerbaijani kamancha, detailing its structural components, construction principles, and acoustic functions. The analysis demonstrates that each part of the instrument including the mulberry-wood bowl, the neck and pegbox configuration, the tension-bearing spike, the simgir anchoring system, the fish-skin membrane, and the dual-bridge structure plays a critical role in ensuring tonal stability and performance quality. The findings show that precise material selection, proportional measurements, and balanced tension distribution are essential, as even small deviations in wall thickness, bridge height, or neck alignment can significantly affect resonance, timbre, and playability. By documenting the kamancha's construction parameters in a standardized and replicable format, this research contributes to the preservation of traditional craftsmanship and provides a technical foundation for future restoration and reconstruction efforts. The study ultimately highlights how traditional luthiery integrates craftsmanship, acoustic reasoning, and empirical observation to maintain the cultural and sonic identity of the instrument.

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Introduction

The kemençe (Azerbaijani kamancha) is one of the most deeply rooted and characteristic bowed instruments of the Caucasian and Near Eastern musical cultures. Throughout cultural history, it has been an integral part of both musical expression and social rituals; with its timbre, technical structure, and performance style, it has played a fundamental role in shaping regional musical identity (Hacıbəyli, 1985). Due to its tone color, closeness to the human voice, and emotional permeability, the kemençe occupies a central position particularly in mugham performance. Moreover, since the geographical spread of the instrument extends from Asia Minor to the Caucasus, and from Iran to Central Asia, it also holds international significance from an organological perspective. The kamancha is one of the oldest and most beloved musical instruments of the Azerbaijani people. It has an extremely soft, delicate, and captivating sound. Its tone is very close to the human voice and, when performed, it draws the listener into contemplation and the world of imagination.

Azerbaijani kemençe

Uzeyir Hajibeyli stated the following about the kamancha: “The kamancha is the musical instrument with the most melodic sound among Azerbaijani instruments.” The kamancha is also known by similar names in many countries. For

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example, it is known as *kamanqa* in the Caucasus, Iran, and Afghanistan, as *kamanqa* in Egypt, as *ıklığ* in Türkiye, and as *ıklık* in Central Asia. Research shows that the distribution area of the kamancha instrument covers Asia Minor, the Caucasus, the Near East, and Central Asia.

The word “kamancha” is formed by the combination of *kaman*, meaning bow, and the suffix “-ça,” derived from the verb “to play,” which indicates that the instrument is played with a bow. According to some researchers, the kamancha evolved from instruments that were formerly played with a plectrum. Instead of a plectrum, this instrument uses a bow approximately 70 cm long, made from horsehair.

Although many studies exist on kemençe performance and repertoire, research that technically presents the instrument’s construction measurements, material standards, acoustic balances, and repair principles remains limited. Since much of the knowledge transmitted through master practices is based on oral tradition, placing construction and restoration knowledge within a scientific framework emerges as an important necessity in the field of organology (Memmedov, 2024; Salimian Rizi, 2024). As emphasized by Zeller (2019), systematically documenting the technical parameters of traditional instrument making is a critical step both for preserving cultural heritage and for enabling scientific examination of acoustic performance.

This study examines in detail the structural characteristics of the professional kemençe, its measurements and proportions, material selection criteria, membrane, bridge, neck, and bow systems, acoustic interactions, and repair processes. In addition, parameters such as the moisture content of the wood types used in kemençe making, membrane tension, skewer and *simgir* structures, bridge height, and neck geometry, and their effects on sound production, are technically evaluated. In this way, the applied knowledge of master instrument makers has been documented in written form, and a reference model aimed at standardization in the field of organology has been presented.

Recent studies published in the *Turkish Journal of Organology* also point to the necessity of systematically documenting the construction knowledge of traditional instruments in the region. Memmedov’s (2024) study on tar construction and restoration reveals the effect of the functional integrity of components on acoustic quality, while Ramadani’s research on Albanian craftsmanship emphasizes the importance of master knowledge in terms of cultural transmission. Çalkap and Çiftçi’s (2025) study on the Unified Kanun model demonstrates the need for innovative approaches in organology, while Salimian Rizi’s (2025) applied examination of Iranian tar and setar construction highlights the contemporary value of placing traditional instrument knowledge within a scientific framework. The common aspect of these studies is their emphasis on the necessity of systematically documenting measurements, materials, and technical stages in traditional instrument making.

Research Problem

The lack of standardization in the measurements used in traditional kemençe construction, variations in material selection from one master to another, and the absence of scientific criteria in repair processes lead to inconsistencies in the acoustic quality of the instrument. This study aims to address these technical deficiencies by developing a detailed, systematic, and measurable framework for the construction and maintenance processes of the kemençe.

Method

This study was conducted using an applied organology method; the structural components of the kemençe were directly measured, and the stages of the construction process were analyzed together with master practices. Technical processes such as wood carving, membrane placement, adjustment of bridge and neck angles, assembly of *simgir* and skewer components, bow making, and rosin application were documented through both observational analysis and applied examination.

Findings

The bowl of the kamancha is made of walnut wood. The diameter of the bowl is 215–220 mm, the diameter of the opening is 120 mm, and the height is 165 mm.



Photo 1. Professional kamancha

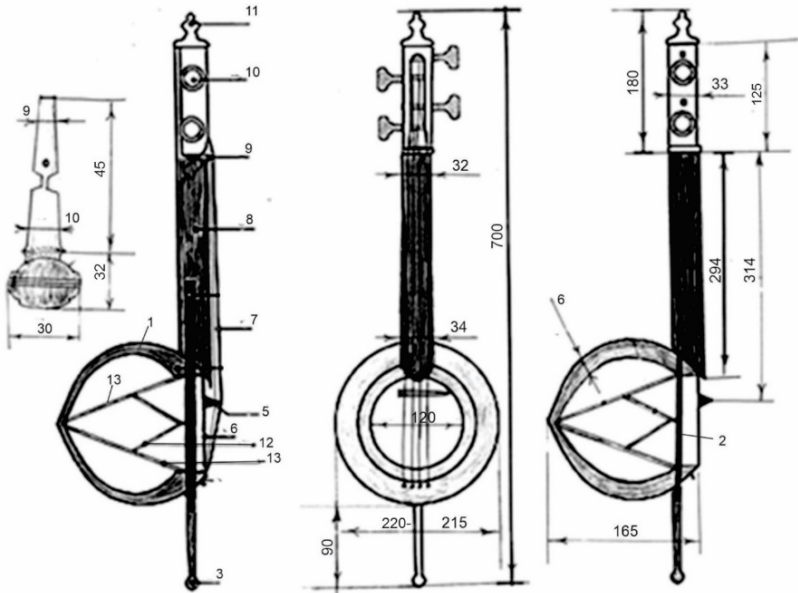


Figure 1. Measurements of the professional kamancha

Table 1. Names of the parts of the professional kamancha

№ Parts of the Professional Kamancha	
1	Bowl
2	Skewer (internal bowl support)
3	Support skewer (knee support)
4	Simgir (string hook)
5	Body bridge
6	Skin stretched over the body surface
7	Strings (4 pieces)
8	Neck
9	Nut
10	Bridges (4 pieces)
11	Crown
12	Internal plectrum
13	Resonator
14	Knee support

Table 2. Measurements of the professional kamancha

Nº	Names of the parts of the instrument	Measurement of the parts of the kamancha
1	Bowl opening diameter	120
2	Bowl diameter	215-220
3	Bowl height	165
4	Scale length	314
5	Neck length	294
6	Total length	700
7	Length of the pegbox including the crown	180
8	Diameter of the neck at the body joint	34
9	Length of the neck at the pegbox section	32
10	Wall thickness of the bowl	6
11	Pegbox diameter	33
12	Diameter of the bridge (aşık) socket	30
13	Bridge cone	9-10
14	Length of the knee support spike	90-100

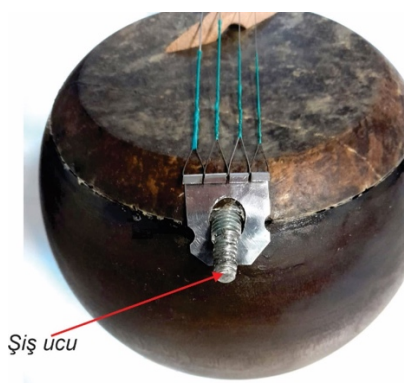
The bowl is carved from a walnut log. The log must be green; otherwise, when dry, carving the inner and outer surfaces of the bowl on the lathe becomes extremely difficult. The wall thickness of the bowl should be approximately 6–7 mm. At the rim, however, the thickness should be greater, around 15–16 mm. The reason for this is that the spike of the kamancha passes through the rim area of the bowl, and the tension force of the strings applies pressure to the bowl at this point. In order to withstand this pressure, the wall in this area must be thick.

Different methods are also applied in the bowl to balance the tension force of the strings. For example, the sections where the spike passes through the bowl should be glued so that all the pressure is borne by the spike.

Spike. The function of the spike is to connect the bowl to the neck. At the same time, a protrusion is left on the back side of the bowl to carry the *şimgir* and to attach the knee support spike. The knee support spike is attached to this protrusion (Photo 2).

It should be noted that when the bowl is carved in a green state, it should be carved 5–6 mm larger than the specified measurements. This is because, once the bowl dries, the measurements should correspond to the final dimensions shown in Figure 1. After carving the bowl in a green state, a protrusion with a thickness of 60–70 mm and a length of 50–60 mm is left on the back side. This allows the inner and outer surfaces to be sanded to an ideal form after the bowl has completely dried.

After the bowl is varnished, it is painted with a walnut-colored water-based stain. Once dry, a transparent filler varnish is applied. After the filler dries, it is lightly sanded. Finally, a transparent lacquer is applied to achieve a completely smooth surface.

**Photo 2.** Spike

Neck. The neck is carved on the lathe together with the pegbox. The total length of the neck (neck + pegbox + crown together) is 475 mm (Photo 3). The length of the crown section may be 55 mm or longer; this varies according to the maker's preference.



Photo 3. Neck

The measurements of the neck are given in Figure 2. The neck is carved entirely from fully dried walnut wood. During preparation, the diameter at the pegbox section should be smaller than the diameter at the point where the neck connects to the body. The surface of the neck must be completely smooth. The pegbox and crown sections may be painted in the same manner as the bowl; however, oiling the neck section with walnut oil is more appropriate. In some cases, an ebonite plate is placed on the surface of the neck where it comes into contact with the strings. This allows the fingers to slide more comfortably and freely over the strings. The bridges (*aşıklar*) of the kamancha are also made of walnut wood.

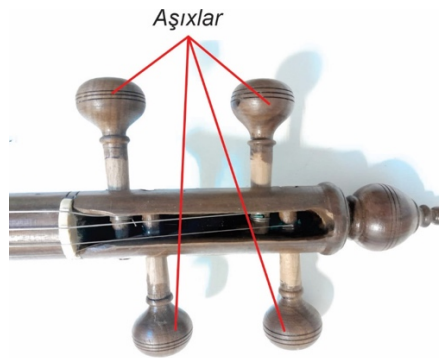


Photo 4. Tuning pegs (*aşıklar*)

The measurements of the tuning pegs (*aşıklar*) are shown in Photo 4. It is recommended that the color of the pegs be compatible with the color of the kamancha and the pegbox section.

Knee support spike: Its length may be 9–10 mm or longer. This measurement can be adjusted to be longer or shorter depending on the performer's height and sitting posture.



Photo 5. Knee support spike (*şiş*)

It is recommended that the part resting on the knee be oval in shape. This form allows the spike to sit more firmly on the knee and prevents the kamancha from slipping off the knee during performance.

Simgir: As its name suggests, the simgir is the part placed on the back of the bowl to hold and secure the strings.

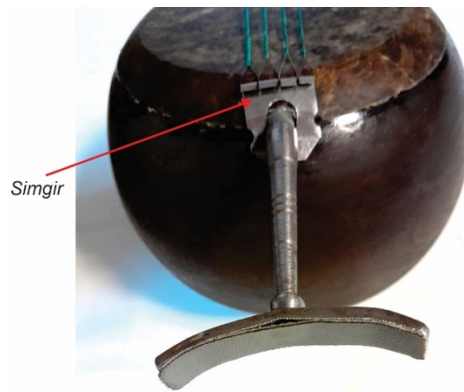


Photo 6. Simgir

The element that carries and holds the simgir in place is the spike. The simgir is mounted onto the spike. The strings emerging from the simgir first pass over the bridge on the bowl, then over the bridge on the neck, and are finally wound onto the tuning pegs (aşıqlar). The function of the tuning pegs is to tune the strings and keep them in tune. See Photo 6.

Membrane (fish skin)

The membrane of the kamancha is made of fish skin (generally salmon or catfish). After the fish is caught, its body is gently struck with a thin stick to soften it so that the skin can be easily separated, and the skin is then carefully removed. After the skin is peeled off, the inner surface is completely cleaned of oils and dried in a place away from direct sunlight.



Foto 7. Fish skin

The dried skin is re-soaked before being stretched onto the kamancha body (the surface of the bowl), preferably for two days. After it becomes wet and flexible, it is placed tightly over the bowl. The skin is fixed to the edge of the bowl using PVA adhesive. The width of the bonded area between the skin and the bowl should be approximately 20–25 mm.

Bridge (Xərək):

The bridge placed on the bowl is made of walnut wood. Its length is 60 mm and its height is 15 mm.



Photo 8. Bonded area between the skin and the bowl

The distance between the neck plane and the bowl plane (Figure 2) is 15 mm. Depending on variations in this distance, the height of the bridge may vary (Photo 9).

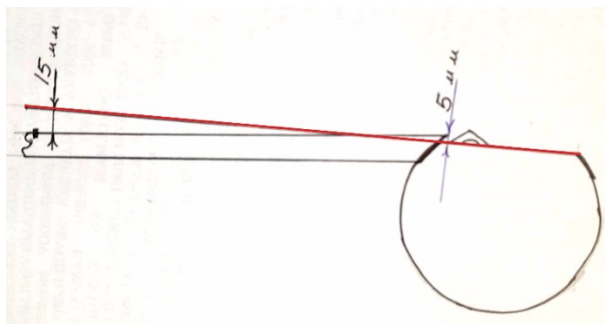


Figure 2. Distance between the neck plane and the bowl plane

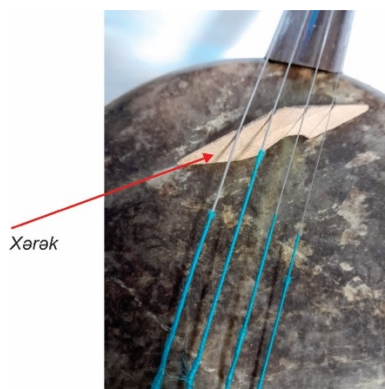


Photo 9. Bridge

Nut: The nut is made of bovine bone. Its function is to correctly regulate the spacing between the strings and to adjust the height between the strings and the neck (Photo 10).

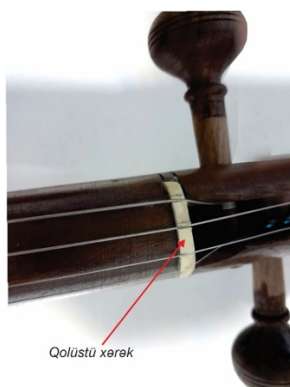


Photo 10. Nut

The distance between the neck and the string should be 1 mm. Depending on the performer's habit, this distance may be slightly smaller or larger; however, a greater distance is not recommended. When the distance increases, the string cuts into the finger, the finger exerts more force during performance, and tuning instabilities occur.

Bow (violin bow / kaman): The bow of the kamancha is made from a rod (wooden stick) with a length of 70 cm. Cylindrical pieces made of copper or aluminum are placed at both ends of the rod. The horsehair strings are attached to the rod by means of square metal rings.



Photo 11. Bow

A strap is attached to the part held by hand; by means of this strap, it is possible to tension the hairs (strings). The thickness of the bow stick may be 0.7, 0.8, 0.9, or 1 cm. This diameter is uniform along the entire length of the stick.

The thickness of the hairs used in the kamancha bow is approximately four times greater than that of the hairs used in a violin bow.

The hairs of the kamancha bow may be white or dark chestnut in color.



Photo 11. Bow

A strap (belt) is attached to the part held by hand; by means of this strap, it becomes possible to tension the strings (hairs). The thickness of the rod may be 0.7, 0.8, 0.9, or 1 cm. This diameter is uniform along the entire length of the rod.

The thickness of the hairs of the kemençe bow is approximately four times greater than that of the hairs of a violin bow.

The kemençe hair may be white or dark chestnut in color.

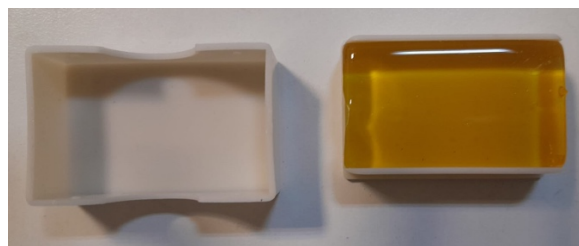


Photo 12. Rosin (Colophony)

More precisely, rosin creates an adhesive contact surface between the string and the hair, increasing friction and thereby enabling sound production.

Conclusion

This study has systematically presented the construction and restoration processes of the professional Azerbaijani kemençe within an organological framework and has documented in detail the fundamental technical parameters that determine the acoustic character of the instrument. The findings demonstrate that all components of the kemençe, including the body (bowl), neck, spike, simgir, membrane, bridge, and bow, are shaped not only according to aesthetic considerations but also in accordance with functional and acoustic logic. Structural details such as carving the bowl from green walnut wood, increasing wall thickness in the rim area, positioning the spike to withstand string tension, and applying the membrane at the correct moisture level are of critical importance for both the durability and sound quality of the instrument.

As emphasized by Memmedov (2024) in his technical study on tar construction, each component of traditional string instruments serves a specific function, and correct understanding of these functions directly affects acoustic balance. The findings of this study show that details such as bridge height, the distance between the neck and bowl planes, the positioning of the strings on the neck, and the thickness of the bow hairs determine both playing comfort and timbral stability in the kemençe. Similarly, the applied study conducted by Salimian Rizi (2024) on the Iranian tar highlights the effects of wood dryness, membrane tension, and neck geometry on sound production, and this study confirms that similar technical principles apply to the kemençe.

Zeller's (2019) methodological approach to traditional instrument reconstruction argues that construction processes should rely not only on historical transmission but also on engineering, material science, and experimental acoustics. By analyzing the structural systems of the kemençe in detail, this study has transformed knowledge transmitted through

oral master-apprentice tradition into a measurable, comparable, and standardizable form, thus presenting a model fully consistent with the scientific framework proposed by Zeller.

In conclusion, this research makes a significant contribution by presenting the technical construction characteristics of the Azerbaijani kemençe in an applied and systematic manner, supporting both the preservation of cultural heritage and the establishment of a scientific basis for modern construction and restoration practices. The study serves as a strong reference for future organological analyses, acoustic optimization studies, and instrument standardization initiatives. Moreover, the detailed documentation of the kemençe construction process enables technical knowledge that might otherwise be lost through oral transmission to be transformed into a permanent and accessible scientific resource.

Acknowledgement

This study was carried out thanks to the technical facilities and research environment provided by the Scientific Research Laboratory of the Azerbaijan National Conservatory. I would like to thank the institution for its support and working conditions during the research process. All photographs, drawings, and measurement sketches included in this article are original materials prepared by Memmedeli Mirel Memmedov to document the reconstruction process of the instruments. I also thank all my colleagues who supported the research with constructive opinions and contributions at various stages.

Biodata of Author



Dr. **Mamedali Mirali Mamedov**, music researcher and musical instrument restorer. Since 2010, he has been working as the head of the “Improvement of National Musical Instruments” (*Milli Musiqi Alətlərinin Təkmilləşdirilməsi*) research laboratory at the Azerbaijan National Conservatory (*Azərbaycan Milli Konservatoriyası*). Over the years, 64 of Mamedali Mamedov’s scientific works have been registered with the Copyright and Intellectual Property Agency (*Müəllif Hüquqları və İntellektual Mülkiyyət Agentliyi*), and dozens of scientific articles and conference materials have been published. The ensemble “In the Footsteps of Time” (*Zamanların İzində*), consisting of ancient musical instruments, was founded by Mamedali. Mamedali Mamedov has created a four-cornered drum (*dördguşəli nağara*), a square drum (*kədrat nağara*), and a “chovgan” (*çovqan*, conductor’s baton) for the National Military Band (*Milli Hərbi Orkestr*). In addition, he has developed new musical instruments that produce sounds at different registers and registered them in the database of Azerbaijani musical instruments in collaboration with the Copyright Agency. In 2018, the book “Improvement of Azerbaijani Folk Musical Instruments” (*Azərbaycan Xalq Musiqi Alətlərinin Təkmilləşdirilməsi*) was published.

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Research Article

A bibliographic study of the kaval instrument in the context of Türkiye

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Abstract

This study aims to reveal the bibliographic structure of academic studies on the kaval instrument in Türkiye and to examine their distribution according to year, publication type, and subject area. A qualitative research approach was adopted, and document analysis was employed as the research method. The data consisted of academic studies published between 1942 and 2025 that included the term “kaval” in their titles. The studies were accessed through the Council of Higher Education National Thesis Center, DergiPark, Academia, Google Scholar, the proceedings of the 1st International Kaval Symposium, and previously published bibliographic studies. The identified studies were classified and analyzed according to publication year, publication type, and subject area. The findings identified 83 academic studies on the kaval across eight different study types: 28 master’s theses, 3 doctoral dissertations, 4 proficiency-in-art theses, 23 articles, 14 conference papers, 9 method studies, 1 opinion paper, and 1 symposium. In addition, one study whose type could not be determined was identified. The findings indicate that academic output on the kaval increased markedly after 2000, with the highest number of studies published in 2014. In terms of subject areas, performance techniques constituted the most extensively studied topic, followed by methodology, general review and analysis, and education. In contrast, technology-oriented studies remained notably limited. By providing a comprehensive overview of the current state of kaval literature, this study offers a bibliographic framework for future research, particularly in technology, organology, interdisciplinary studies, and other underexplored areas.

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Introduction

The kaval, one of Anatolia’s ancient wind instruments, has undergone significant transformations throughout history in terms of its performance practices and contexts of use. Today, although it continues to be taught in both public and private institutions, at the academic level as well as in individual music education, its traditional position within Anatolian folk culture appears to be gradually weakening under the dominant influence of popular culture. This tendency may be regarded as a threat to the visibility and functionality of the kaval within the continuity of cultural traditions.

Considering this situation, increasing the number of studies on the kaval appears essential both for sustaining the cultural transmission of the instrument and for preserving its existence as a tangible representative of the Anatolian folk music tradition. An increase in original studies addressing the historical, organological, and pedagogical dimensions of the kaval would not only enrich the body of knowledge in the field but also enable researchers to access the relevant literature in a more systematic and accessible manner. Therefore, the continuity of comprehensive scholarly research on the subject constitutes an important requirement for the preservation and transmission of cultural heritage.

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The root “kav” is understood to constitute the etymological basis of the word kaval and to refer to the meaning “hollow tube” (Gazimihal, 1961, p. 39). Kaşgarlı Mahmud similarly explains the same root in *Dîvânü Lugâti't-Türk*, drawing attention to the relationship between the instrument's name and its structural characteristics. At the same time, the kaval is known by various names in different languages, particularly Turkish and Greek, reflecting its historically extensive circulation across cultures. In Anatolia, the kaval became closely associated with rural life, emerging as one of the principal elements of pastoral culture and becoming established in the literature as a shepherd's instrument (Picken, 1975, pp. 382–383). This etymological and cultural diversity suggests that certain aspects of the origins and historical functions of the kaval remain unresolved in the literature and require more comprehensive investigation (Yurtçu, 2006, p. 7).

Divided into two principal types, duct-flute and rim-blown kaval, the instrument continues to exist as a wind instrument known by different names across various regions of the world and characterized by diverse structural features, performance techniques, and construction materials. Among the regions where the kaval is most extensively performed are the Balkans, particularly Bulgaria, Central Asia—where related instruments are known as kuray—and Anatolia, with Türkiye, Armenia, and Azerbaijan being particularly prominent in the Anatolian context. Given its affinity with the ney and their similar timbral characteristics, the kaval also occupies an important place as an ethnic instrument in the Arabian Peninsula and Mesopotamia. Beyond these traditional geographical areas, however, the kaval has also found a place in various forms of European music and has attained a broad performance sphere due to its structural and acoustic similarities to the flute family (Bilgiç, 2025, p. 11).

Considering its organological relationship with similar wind instruments such as the tütek, ney, flute, and kuray, the kaval may be regarded as part of a broader cultural cluster and is therefore represented in different geographical regions by variants that perform comparable functions.

The Upper Paleolithic period, spanning approximately 50,000 to 10,000 years ago, is regarded as a period characterized by the development of hunting implements and the marked proliferation of cave paintings. One of the earliest known examples of a wind instrument associated with this period, the Divje Babe Flute, is particularly notable for having been made from the femur of a bear. The artifact was discovered in 1995 during archaeological excavations at Divje Babe Cave near the town of Cerklje na Gori in Slovenia. The instrument takes its name from the cave in which the excavations were conducted and is regarded as an important archaeological artifact indicating the use of wind instruments during the Upper Paleolithic period.



Figure 1. Divje Babe Flute (Web 1)

Another important assessment concerning the history of the kaval is presented in Aytek's (2010) study entitled “The First Musical Instrument: The Flute.” The relevant finding is expressed as follows: The hollow-tube form is the most fundamental physical feature shared by all instruments belonging to the kaval family. This structural characteristic suggests that the historical origins of the kaval extend back to very early periods. Indeed, finds discovered in Hohle Fels Cave near Ulm, Germany, and dated to approximately 36,000 years ago using the thermoluminescence dating method demonstrate that wind instruments based on a hollow-tube structure have a history extending back to the Upper Paleolithic period (Aytek, 2010).



Figure 2. A kaval made of bone (Aydın, 2019)

The kaval, which can be classified into two main categories—duct-flute and rim-blown types—can be further divided into subgroups according to finger-hole configurations, construction materials, and the design of the blowing end (mouthpiece). These organological differences have been shaped by the geographical regions in which the instrument is performed and by local performance practices. Consequently, throughout its historical development, the kaval has acquired diverse forms and characteristics that have persisted to the present day.

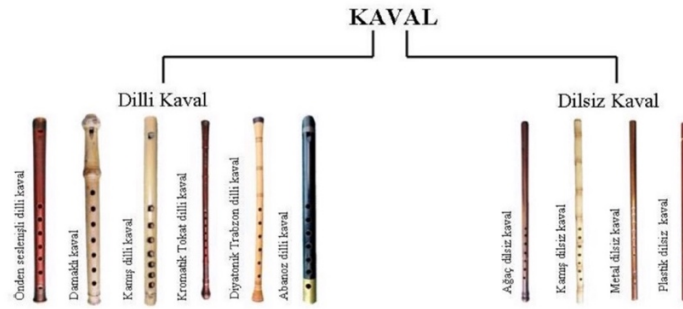


Figure 3. Types of Kaval (Kastelli, 2014, p. 4)

There are two main types of duct-flute kaval used in Anatolia and Mesopotamia. These instruments can be further divided into subgroups according to their structural features and performance characteristics. Although they exhibit similar organological structures, they differ in terms of performance techniques, contexts of use, and approaches to timbre.

The first type, the straight-mouthpiece horlatmalı duct-flute kaval, is widely used in Anatolia, particularly in Tokat, Ordu, and Bolu. Indigenous woods such as apricot and black plum are most commonly preferred for its construction, while imported woods such as African rosewood, ebony, and palisander are used to a limited extent (Aydın, 2021). The primary reason for the limited use of imported woods is their high cost. The finger-hole configuration of this type of kaval resembles that of the rim-blown shepherd's kaval, with a total of eight finger holes—seven on the front and one on the back. The straight design of the mouthpiece is preferred to achieve the regional performance style and the characteristic timbre traditionally associated with the region.



Figure 4. Body of a horlatmalı duct-flute kaval (Yaşayanca, 2022, p. 63).

The average length of these instruments ranges from 30 to 40 cm, and their tonal range extends to approximately 2.5 octaves (Yaşayanca, 2022, p. 39).



Figure 5. Mouthpiece structure of the horlatmalı duct-flute kaval (Yaşayanca, 2022, p. 64)

Another type of horlatmalı duct-flute kaval is widely found in the Eastern Black Sea Region, particularly in Trabzon. Plum, boxwood, and komar wood are commonly preferred for the construction of kavals produced in this region. Eastern Black Sea examples have six finger holes on the front and no finger holes on the back. Plum wood is particularly prominent in this region, and the length of these kavals can reach approximately 60 cm. The greater length of the instrument results in a lower-pitched tonal range.



Figure 6. Horlatmalı duct-flute kaval used in the Trabzon region (Koyuncu, 2019, p. 30)

In contrast, horlatmalı duct-flute kavals found in the western parts of the Black Sea region have one additional finger hole on the back, bringing the total number of finger holes to seven. Kavals produced in these regions generally range from 30 to 35 cm in length and are observed to have a higher-pitched tonal range (Ömer Parlak, regional performer and kaval maker, personal communication, March 18, 2025, as cited in Bilgiç, 2025).

Duct-flute kavals used in different regions of Anatolia generally have a right-angled mouthpiece. Although the construction materials of these instruments vary, their finger-hole configurations are largely similar. While woods such as ebony, palisander, African rosewood, and olive are occasionally used, apricot, plum, and black plum are more commonly preferred. In addition to wooden materials, examples of duct-flute kavals made of reed can also be found.

The finger-hole configuration of these kavals consists of eight holes in total, with seven on the front and one on the back. This type of duct-flute kaval is performed in various regions of Anatolia, including Erzincan, Tokat, Diyarbakır, Bolu, Gaziantep, Sivas, Kahramanmaraş, Ordu, Adıyaman, Trabzon, Amasya, and Giresun. Due to their relatively limited sound volume, these instruments may be said to be preferred primarily for indoor performances and in the context of traditional oturak gatherings (Paksoy & Gök-Ayyıldız, 2020, as cited in Bilgiç, 2025).

Examples of duct-flute kaval performance shaped by regional musical traditions and performance practices can be found both within Türkiye and in geographical regions beyond its borders. These examples are important in demonstrating the functions assumed by the instrument in different cultural contexts, the diversity of its performance techniques, and the determining influence of regional performance styles on the instrument.

The performance examples examined reveal regional differences in such elements as breath control, articulation, ornamentation techniques, fingering preferences, and the use of tonal range. These differences arise not only from the individual preferences of performers but also from the musical aesthetics, repertoire characteristics, and social performance settings of the respective regions.

Examples from outside Türkiye demonstrate that, although the duct-flute kaval is primarily associated with Anatolia and Mesopotamia, it continues to exist in neighboring regions and areas of cultural interaction through different performance styles. This provides important insights into the historical circulation of the instrument and processes of intercultural interaction.

In this context, the performance examples presented demonstrate that the duct-flute kaval should be considered not only in terms of its structural characteristics but also in relation to its performance practices and stylistic variations, thereby making the instrument's regional and cultural diversity clearly visible.

The rim-blown shepherd's kaval, the most widely used member of the kaval family, is found across many different geographical regions of the world. In addition to traditional construction materials, it has recently also been produced using materials such as bamboo and Delrin. Owing to its finger-hole configuration, which enables it to accompany different musical genres in both solo and ensemble performances, the instrument has acquired a broad range of uses. Sinan Çelik is among the leading figures who have made significant contributions to the diversification and development of the rim-blown shepherd's kaval in Türkiye.

Sinan Çelik was born in Sarıkamış in 1957. During his childhood, he developed an interest in the mandolin and percussion instruments and was influenced by the dengbêj tradition within his family. In his youth, he received training in piano and recorder and later met Arif Sağ. With Sağ's support, he enrolled at the ITU Turkish Music State Conservatory, during which period he rapidly developed his kaval performance skills (Türk, 2021, pp. 28–29).

During the 1980s, Sinan Çelik's invitations to perform as an accompanist in album recordings and stage performances revealed the need to diversify the kaval in ways that could meet different musical requirements. This need arose from the necessity of accurately reflecting the regional performance style of each musical work and providing instruments with characteristics appropriate to its performance. Developments in kaval performance and construction in Bulgaria were influential in this process. Çelik personally traveled to Bulgaria, and the experience he acquired there in performance and instrument making played an important role in the diversification of the rim-blown shepherd's kaval (Türk, 2021, pp. 20–21).

The basic characteristics of the rim-blown shepherd's kaval can be summarized as follows. Depending on the tonal range produced, the instrument varies in length from approximately 45 to 85 cm. Structurally, it can be constructed either as a single-piece or a three-piece instrument. In Türkiye, the traditional and more widespread form is the single-piece kaval. The construction of three-piece kavals is regarded as a relatively recent practice influenced by Bulgarian kaval culture.

Plum and apricot are the most commonly preferred woods for construction. In addition, olive wood and imported woods such as African rosewood, ebony, and palisander are occasionally used, as are synthetic materials such as Delrin. More recently, bamboo has also emerged as a new material option for kaval construction.

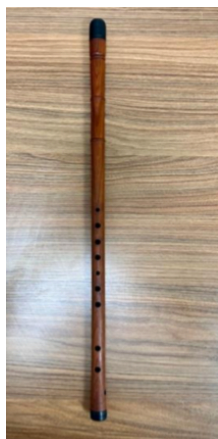


Figure 7. Single-piece kaval (Gazi Bilgiç personal archive)

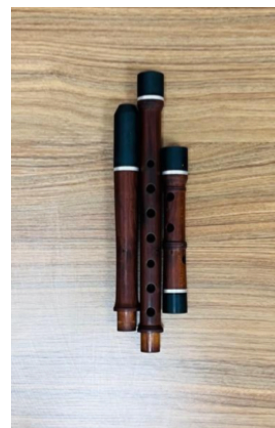


Figure 8. Three-piece kaval (Gazi Bilgiç personal archive)

As with other types of kaval, different performance styles have also emerged for the rim-blown shepherd's kaval. In order to convey regional performance styles more effectively to listeners, these approaches have led to the development of various techniques beyond conventional performance practices. Such techniques expand the performer's expressive possibilities and enable the instrument to adapt to different regional musical characteristics.

In this context, practices such as the tooth-playing technique and drone-producing blowing technique are among the principal alternative performance techniques used on the rim-blown shepherd's kaval. These techniques both increase timbral diversity and make the regional characteristics of performance more distinctive. Selected examples illustrating these performance techniques are presented below.

Bibliography

A bibliography is a type of reference source in which published works related to a particular subject, period, or field are systematically compiled and organized. Its primary purpose is to classify the existing literature according to specified criteria and guide researchers in accessing relevant information.

“The term ‘bibliography,’ formerly translated into Turkish as ‘esame-i kütüb’ and more recently as ‘kitabiyat,’ is derived from the combination of the Greek words ‘biblion,’ meaning book, and ‘graphein,’ meaning to write.

Bibliographies consist of the description and identification of books. The purpose of this field is to provide information about the existence and value of works” (Altuğ & Kılıçarslan, 2016).

Bibliographies do not necessarily provide direct information about the libraries or archives in which the works are held; rather, they function as reference guides that direct researchers to the relevant sources.

In this respect, bibliography constitutes one of the bridges between the production and dissemination of knowledge. It establishes a connection between readers and works, makes the developmental trajectory of a research field visible, and provides a reference framework for future studies.

Related Studies

G. Ö. (2009), in the study entitled “Postgraduate Theses on Flute and Flute Education in Türkiye,” examined postgraduate theses on flute and flute education completed in Türkiye between 1993 and 2006. The theses produced during this period were reviewed and classified according to their subject areas. The findings indicated that a total of 28 postgraduate theses had been completed in these fields, of which 17 focused on flute education and 11 on flute performance.

Özdek, A. (2014), in the study entitled “A Bibliography of Studies on the Kaval in Türkiye,” examined studies on the kaval conducted in Türkiye between 1940 and 2014. The study evaluated 51 written sources, comprising 11 book chapters, 12 articles, 7 conference papers, 1 proficiency-in-art thesis, 7 master’s theses, 8 undergraduate theses, and 6 method books, as well as 9 albums and 4 web-based sources.

Purpose and Significance of the Study

The primary aim of this study is to systematically classify postgraduate theses (master’s, doctoral, and proficiency-in-art theses) and related academic publications focusing on the kaval instrument in Türkiye under specific thematic categories. The classification developed within the scope of this study is expected to serve as a guiding resource for researchers planning to conduct postgraduate research on the kaval in 2026 and beyond by enabling them to become familiar with the existing literature, establish references based on previous studies, and identify potential topics for future research.

Problem Statement

The absence of a systematic classification of academic studies on the kaval in Türkiye with consideration of their historical periods makes it difficult to trace the historical development of the field, analyze thematic trends, and identify new areas of research. Main problem of study;

- The lack of a comprehensive and systematic account of the content, author profiles, publication types, subjects, and thematic distributions of academic studies focusing specifically on the kaval constitutes the main research problem of this study.

Sub-problems of study;

- What is the overall bibliographic distribution of the identified academic studies on the kaval in terms of publication type (thesis, article, conference paper, etc.), authors, and years of publication?
- What is the distribution of the identified academic studies on the kaval by year?
- What is the distribution of the identified academic studies on the kaval according to subject area and type of study?

Method

A qualitative research approach was employed in this study (Creswell, 2007). Document analysis was used as the research method. Document analysis is a qualitative data collection method that involves the systematic examination of written and visual documents containing information relevant to the subject under investigation. Depending on the nature of the research problem, this method enables findings to be obtained from existing documents without the need for interviews or observations (Yıldırım & Şimşek, 2008, p. 188).

This study aims to identify academic studies published in Türkiye between 1942 and 2025 that include the term “kaval” in their titles. Considering the research topic, the method employed, and the nature of the data collected, the

study constitutes descriptive research aimed at determining the current state of postgraduate research in the field of kaval studies. In descriptive analysis, findings obtained through observation should be organized and interpreted in a manner suitable for presentation to the reader. The findings should be classified, summarized, and interpreted according to predetermined themes (Karataş, 2017, p. 78).

Documents

The documents examined in this study consist of academic publications on the kaval instrument produced in Türkiye. The study was limited to academic works published between 1942 and 2025 that contain the keyword “kaval” in their titles. Data were obtained by searching studies accessible through the Council of Higher Education (YÖK) National Thesis Center/documentation resources, DergiPark, Academia, and Google Scholar. Only studies for which either the full text or bibliographic information was accessible through these databases were included in the analysis.

Limitations

This study was limited to academic studies published between 1942 and 2025 that contain the term “kaval” as a keyword in their titles and for which bibliographic information was accessible.

Data Collection and Analysis

A literature review was employed, as “literature reviews, as a research methodology, can contribute to the conceptual, methodological, and thematic development of different fields” (Yıldız, 2022, p. 369). Postgraduate theses on the kaval produced in Türkiye between 1942 and 2025 were retrieved from the Council of Higher Education (YÖK) National Thesis/Documentation Center. Academic studies other than theses were searched through online academic databases, including Google Scholar, Academia, and DergiPark. The literature search was conducted using the keywords and search phrases “kaval,” “rim-blown kaval,” “duct-flute kaval,” “history of the rim-blown kaval,” and “history of the kaval.” The data obtained through these searches were transferred to Microsoft Office Excel 2007. The studies were then classified according to year, publication type, and content, organized into tables, and the findings were presented with explanatory interpretations.

Findings

In this section, the data obtained from the study are presented systematically through tables accompanied by analyses and interpretations.

Bibliographic Distribution of Studies on the Kaval

For this sub-problem, the studies were arranged chronologically, numbered, and tabulated according to publication type, title, and author to ensure clear presentation. Detailed information is provided in this section.

Table 1. Basic bibliographic classification of academic studies on the Kaval

No.	Title of the Study	Author(s)	Type	Year
1	Kaval, Tulum, Çifte (Kaval, Tulum, and Çifte)	Muzaffer Sarısözen	Article	1942
2	Kaval'a Dair (On the Kaval)	Mahmut Ragıp Gazimihal	Article	1962
3	Öz Çalgımız Kaval – Metot 1 (Dilli) (Our Traditional Instrument, the Kaval – Method 1 [Duct-Flute])	Burhan Tarlaşası	Method	1984
4	Öz Çalgımız Kaval (Our Traditional Instrument, the Kaval)	Burhan Tarlaşası	Conference Paper	1986
5	Kaval Metodu (Dilli) (Kaval Method [Duct-Flute])	Burhan Tarlaşası	Method	1988
6	Kaval Metodu (Orta Öğretim İçin) (Dilli) (Kaval Method for Secondary Education [Duct-Flute])	Burhan Tarlaşası	Method	1990
7	Türk Mehterinin Nefesli Sazları Kavalları ve Düdükları (Wind Instruments, Kavals, and Pipes of the Turkish Mehter)	Bahaeddin Ögel	Article	1991
8	Dilli Kaval'ın Çok Sesli Müzikteki Yeri (The Place of the Duct-Flute Kaval in Polyphonic Music)	Burhan Tarlaşası	Article	1997
9	Türk Halk Müziği Nefesli Sazlarında Standardizasyon Sorunu ve Buna Bağlı (Doğrudan) Dilli Kavalın Çoksesli Müzikte (Orkestrada)'ki Yeri (The Standardization Problem in Turkish Folk Music Wind Instruments and the Related Place of the Duct-Flute Kaval in Polyphonic Music [Orchestra])	Burhan Tarlaşası	Conference Paper	1997
10	Türk Halk Müziği Çalgılarından Kavalın Ortaokul ve Lisedeki Müzik Eğitimi Derslerinde Kullanımı (The Use of the Kaval, a Turkish Folk Music Instrument, in Music Education Classes at Middle and High Schools)	Nevzat Acartürk Tübbes	Master's Thesis	2000
11	Dilsiz Kaval Metodu (Rim-Blown Kaval Method)	Adnan Çağ	Method	2003
12	Teke Yöresi Halk Çalgılarından “Sipsi ve Kaval” (“Sipsi and Kaval” as Folk Instruments of the Teke Region)	Mehmet Bedel	Conference Paper	2005

13	Mesleki Müzik Eğitimi Veren Kurumlarda Kaval Eğitim Sürecinin I. Yılında Kullanılan Öğretim Yöntem ve Tekniklerinin İncelenmesi (An Examination of Teaching Methods and Techniques Used in the First Year of Kaval Education in Professional Music Education Institutions)	M. Ulaş Atasoy Tübbes	Master's Thesis	2006
14	Bir Performans Aracı Olarak Kaval ve Teknik Gelişimi (The Kaval as a Performance Instrument and Its Technical Development)	Cihan Yurtçu	Proficiency in Art Thesis	2006
15	Dört Yıllık Müzik Eğitimi Veren Yükseköğretim Kurumlarında ve Konservatuvarlarda Dilsiz Çoban Kavalı Çalma Teknikleri ve Eğitim Müfredatı (Performance Techniques and Curriculum for the Rim-Blown Shepherd's Kaval in Four-Year Higher Education Institutions and Conservatories Providing Music Education)	Kemal Akdemir	Master's Thesis	2006
16	Halk Müziğinde Çoban Kaval Sürü (The Shepherd's Kaval Sürü in Folk Music)	Seher Keçe Türker	Conference Paper	2007
17	Flüt mü, Kaval mı? (Flute or Kaval?)	Süreyya Ülker	Article	2007
18	Anadolu'da Kaval Ezgileri ve "Karakoyun" (Kaval Melodies in Anatolia and "Karakoyun")	Sinan Cem Eroğlu	Article	2011
19	Dilsiz Kaval Metodu (Rim-Blown Kaval Method)	Fedai Tekşahin	Method	2011
20	Türkiye'de Halk Çalgılarının Mesleki Eğitim Sürecinde Kaval Eğitiminin Gelişimi ve Sorunları Üzerine Tespit ve Öneriler (Findings and Recommendations on the Development and Problems of Kaval Education in the Professional Training of Folk Instruments in Türkiye)	Cihan Yurtçu	Conference Paper	2012
21	Ülkemizde Müzik Eğitimi Ana Bilim Dallarında Geleneksel Nefesli Çalgılarımızdan Kaval'ın Yeri ve Önemi (The Place and Importance of the Kaval as a Traditional Wind Instrument in Music Education Departments in Türkiye)	Mustafa Ulaş Atasoy	Article	2013
22	Ülkemizde Kültür, Çalgı ve Eğitim Üçgeninde Kaval (The Kaval within the Triangle of Culture, Instrument, and Education in Türkiye)	Mustafa Ulaş Atasoy	?	2013
23	Ülkemizde Müzik Eğitimi Anabilim Dallarında Geleneksel Nefesli Çalgılarımızdan Kaval'ın Yeri ve Önemi (The Place and Importance of the Kaval as a Traditional Wind Instrument in Music Education Departments in Türkiye)	Mustafa Ulaş Atasoy	Article	2013
24	1. Uluslararası Kaval Sempozyumu (1st International Kaval Symposium)	İTÜ TMDK	Symposium	2014
25	Orta Asya, Anadolu ve Balkan Coğrafyasında Kaval (The Kaval in Central Asia, Anatolia, and the Balkans)	Cihan Yurtçu	Article	2014
26	Kaval mı, Düdük mü? (Kaval or Pipe?)	Mustafa Ulaş Atasoy	Opinion Paper	2014
27	Bulgaristan Kavalı: Tarihi, Kaval Çeşitleri ve Performans Türleri (The Bulgarian Kaval: Its History, Types of Kaval, and Performance Styles)	Nikolay Doktorov	Conference Paper	2014
28	Kaval İcrasında Genişletilmiş Teknikler ve Çağdaş Müzik Uygulamaları (Extended Techniques in Kaval Performance and Contemporary Music Practices)	Serkan Şener	Conference Paper	2014
29	Türkiye'de Kaval Hakkında Yapılmış Çalışmalar Üzerine Bir Bibliyografya (A Bibliography of Studies on the Kaval in Türkiye)	Atilla Özdek	Conference Paper	2014
30	Kavalda Perde Düzenlerinin Oluşumunun Halk Müziği Repertuarı, Notasyonu ve Anadolu Kaval Çalma Geleneği ile İlişkisi (The Relationship between the Formation of Finger-Hole Systems on the Kaval and Folk Music Repertoire, Notation, and the Anatolian Kaval Performance Tradition)	Cihan Yurtçu	Conference Paper	2014
31	Kavals in Bulgaria	Lyuben Dossev	Conference Paper	2014
32	Doğu Karadeniz Halk Müziği Kültürü İçerisinde Dilli Kaval'ın Kullanım Alanları ve İcra Teknikleri (Contexts of Use and Performance Techniques of the Duct-Flute Kaval in Eastern Black Sea Folk Music Culture)	Feyzullah Volkan Koyuncu	Conference Paper	2014
33	Dilsiz Çoban Kavalı Metodu Çerçevesinde Yeni Seslendirme Teknikleri (New Performance Techniques within the Framework of the Rim-Blown Shepherd's Kaval Method)	Fedai Tekşahin	Conference Paper	2014
34	Kaval Eğitiminde Metot Sorunu ve Başlangıç Düzeyine Yönelik Bir Metot Önerisi (The Methodological Problem in Kaval Education and a Method Proposal for Beginners)	Deniz Yıldız	Conference Paper	2014
35	Dilsiz Kaval Metodu (Rim-Blown Kaval Method)	Serkan Şener	Article	2014
36	Orta Asya Özbek ve Tacik Halklarında Ney ve Kaval'a Benzeyen Üflemlili Çalgılar (Wind Instruments Resembling the Ney and Kaval among the Uzbek and Tajik Peoples of Central Asia)	Alexander Djumaev	Conference Paper	2014
37	Doğu Karadeniz Müziği Çalgılarından Kaval, Kemençe ve Tulum İçin Stüdyo Kayıt ve Mikrofonlama Teknikleri (Studio Recording and Microphone Techniques for the Kaval, Kemençe, and Tulum of Eastern Black Sea Music)	Öncü Caner Koyuncu	Master's Thesis	2015
38	Türkiye'de Dilsiz Kaval İçin Yapılmış Metodolojik Çalışmalar Üzerine Bir İnceleme (A Review of Methodological Studies on the Rim-Blown Kaval in Türkiye)	Aytunç Aydın, Aydar Deniz	Article	2015
39	Türkiye'de Dilsiz Kaval İçin Yapılmış Metodolojik Çalışmalar Üzerine Bir İnceleme (A Review of Methodological Studies on the Rim-Blown Kaval in Türkiye)	Aytunç Aydın	Master's Thesis	2017
40	Burdur Yöresi Halk Müziği Geleneğinde Müzikal Türlerin Dilsiz Kaval ile İcra ve Özellikleri (Performance and Characteristics of Musical Genres on the Rim-Blown Kaval in the Folk Music Tradition of the Burdur Region)	Serkan Yıldırım	Master's Thesis	2017
41	Dilsiz Kavalın Akustik Açısından İncelenmesi (An Acoustic Examination of the Rim-Blown Kaval)	Ali Bedel	Master's Thesis	2017
42	Cumhuriyetin İlk Yıllarından Günümüze Kaval'ın Gelişim Süreci (The Development of the Kaval from the Early Years of the Republic to the Present)	Ali Bedel	Article	2018
43	Trabzon ve Çevresinde Kullanılan Dilli Kavalın İcra Teknikleri ve Dilsiz Kaval'a Adaptasyonu (Performance Techniques of the Duct-Flute Kaval Used in Trabzon and Its Surroundings and Their Adaptation to the Rim-Blown Kaval)	Feyzullah Volkan Koyuncu	Master's Thesis	2019
44	Türk Müziği Eğitimi Veren Konservatuvarlarda Dilsiz Kaval Sazının Meslek Çalgısı Olarak Tercih Durumuna Yönelik Tespitler (Findings on the Preference for the Rim-Blown Kaval as a Professional Instrument in Conservatories Providing Turkish Music Education)	Serhat Karakoç	Master's Thesis	2019

45	Türkiye’de Dilsiz Kaval İcracılarının Kaval Eğitime Yönelik Görüşlerinin İncelenmesi (An Examination of Rim-Blown Kaval Performers’ Views on Kaval Education in Türkiye)	Bayram Kurt	Master’s Thesis	2019
46	Türkiye’de Dilsiz Kaval Yapım Teknikleri ve İcraya Yansımaları (Rim-Blown Kaval Construction Techniques in Türkiye and Their Reflections on Performance)	Berat Talat Karakoç	Master’s Thesis	2019
47	Türkiye’de Dilsiz Kaval Yapım Teknikleri ve İcraya Yansımaları (Rim-Blown Kaval Construction Techniques in Türkiye and Their Reflections on Performance)	Berat Talat Karakoç	Article	2019
48	Horlatmalı Dilli Kaval ve İcra Teknikleri (The Horlatmalı Duct-Flute Kaval and Its Performance Techniques)	Aytunç Aydın	Article	2019
49	Yaşayan İnsan Hazinelerinden Tokat’lı Yaşar Güç ve Dilli Kaval İcracılığının Tahlili (An Analysis of Yaşar Güç of Tokat, a Living Human Treasure, and His Duct-Flute Kaval Performance)	Aytunç Aydın	Doctoral Dissertation	2020
50	Anadolu’da Kullanılan Dilli Kaval (The Duct-Flute Kaval Used in Anatolia)	Oğuz Paksoy, Sevilay Gök Ayyıldız	Article	2020
51	Dilsiz Kaval Eğitime Yönelik Metodolojik Bir Çalışma (A Methodological Study on Rim-Blown Kaval Education)	Haydar Tanrıverdi	Proficiency in Art Thesis	2020
52	Dilsiz Kaval İcrasında Alterasyon ve Süsleme İşaretlerinin İncelenmesi (An Examination of Accidentals and Ornamentation Symbols in Rim-Blown Kaval Performance)	Uğur Eren Erdoğan	Master’s Thesis	2020
53	Dilsiz Kavalda Diş ile Çalım Tekniği – Güneydoğu Anadolu ve Doğu Anadolu Bölgesi Örneklemleri (The Tooth-Playing Technique on the Rim-Blown Kaval: The Case of Southeastern and Eastern Anatolia)	Emre Altürk	Master’s Thesis	2021
54	Güzel Sanatlar Liselerinin Çalgı Eğitimi Branşlarından Kaval Dersi Öğretim Programının İncelenmesi (An Examination of the Kaval Course Curriculum in Instrument Education at Fine Arts High Schools)	Eren Gedik	Master’s Thesis	2021
55	Kırşehir Halay Havalarının Dilsiz Kaval ile İcrasındaki Özelliklerinin İncelenmesi (An Examination of the Performance Characteristics of Kırşehir Halay Melodies on the Rim-Blown Kaval)	Sezin Naz Ürüm	Master’s Thesis	2021
56	Sinan Çelik’in Hayatı ve Dilsiz Kaval Çalgısına Katkıları (The Life of Sinan Çelik and His Contributions to the Rim-Blown Kaval)	Yasin Türk	Master’s Thesis	2021
57	Tokat Yöresi Horlatmalı Dilli Kaval’ın Orkestra İçerisinde Kullanımına Yönelik Bir İnceleme (An Examination of the Use of the Tokat Region Horlatmalı Duct-Flute Kaval in the Orchestra)	Ekrem Uğuz	Master’s Thesis	2021
58	Dilsiz Kaval Metodu (Rim-Blown Kaval Method)	Aytunç Aydın	Method	2021
59	Dilsiz Kaval İcra Notasyonunda Kullanılan Terim ve İşaretler Üzerine Bir Model Önerisi (A Model Proposal for Terms and Symbols Used in Rim-Blown Kaval Performance Notation)	Haydar Tanrıverdi	Article	2021
60	Dilsiz Kaval Çalgısında İcrayı Kolaylaştıran “Delik Akortlama” Holetuning Aparatı (The “Hole-Tuning” Device for Facilitating Performance on the Rim-Blown Kaval)	Haydar Tanrıverdi	Article	2021
61	Horlatmalı Dilli Kaval ve Dilsiz Kaval Çalgılarının Anatomik Yapısı Bağlamında Türk Halk Müziği’nde İcra Uyarlaması (Performance Adaptation in Turkish Folk Music in the Context of the Anatomical Structures of the Horlatmalı Duct-Flute Kaval and Rim-Blown Kaval)	Sercan Özkeleş, Aytunç Aydın	Article	2021
62	Dilsiz Kaval Eğitiminde Karşılaşılan Sorunlar (Problems Encountered in Rim-Blown Kaval Education)	Furkan Aslan	Master’s Thesis	2021
63	Kavalın Değişen Performans Alanları ve Yeniden İnşa (Changing Performance Contexts and the Reconstruction of the Kaval)	Ersin Günaslan	Master’s Thesis	2022
64	Bolu Yöresi Geleneksel Müzik Uygulamalarında Dilli Kaval (The Duct-Flute Kaval in Traditional Music Practices of the Bolu Region)	Barış Yaşayan	Doctoral Dissertation	2022
65	Türk Halk Müziği Çalgıları İçin Çalgı Uygulama Teknikleri: Kemane, Kaval ve Bağlama (Instrumentation Techniques for Turkish Folk Music Instruments: Kemane, Kaval, and Bağlama)	Salih Kartal	Proficiency in Art Thesis	2023
66	TRT Repertuarı Sözsüz Eserler Üzerinde Aydın Yöresi Zeybeklerinin Dilsiz Kaval Çalgısına Uyarlanması (Adaptation of Zeybek Melodies from the Aydın Region to the Rim-Blown Kaval with Specific Reference to Instrumental Works in the TRT Repertoire)	Ferhat Küçük	Master’s Thesis	2023
67	Nihavent Makamı Dizisindeki Türkülerin Dilsiz Kaval İcrasına Yönelik Transpozisyon Uygulamaları (Transposition Practices for Performing Folk Songs in the Nihavent Makam Scale on the Rim-Blown Kaval)	Yılmaz Ateş	Master’s Thesis	2024
68	Ney ve Dilsiz Kavalın Geleneksel İcrasında Görülen Yorum Farklılıklarının İncelenmesi (An Examination of Interpretive Differences in the Traditional Performance of the Ney and Rim-Blown Kaval)	Cengiz Altan	Article	2024
69	Mesleki Müzik Eğitimi Veren Kurumlardaki Kaval Eğitime İlişkin Akademisyen ve Öğrenci Görüşleri: Karma Yöntem Araştırması (Academics’ and Students’ Views on Kaval Education in Professional Music Education Institutions: A Mixed-Methods Study)	Oktay Akar	Master’s Thesis	2024
70	Dilsiz Kaval Metodu II (Rim-Blown Kaval Method II)	Aytunç Aydın	Method	2024
71	Dilsiz Çoban Kavalı ile İcra Edilmiş “Sarıkamış Ağıtı”nın Müzikal Analizi (Sinan Çelik İcrası Örneği) (Musical Analysis of “Sarıkamış Ağıtı” Performed on the Rim-Blown Shepherd’s Kaval: The Case of Sinan Çelik’s Performance)	Kemal Akdemir, Mutlu Demir Torun	Article	2025
72	Ordu’nun Tanınmayan Usta Kaval İcracısı: Kemal Ataş (Kemal Ataş: An Unrecognized Master Kaval Performer from Ordu)	Aytunç Aydın	Article	2025
73	Dilsiz Kavalda Üfleme Teknikleri (Blowing Techniques on the Rim-Blown Kaval)	Ezmir Memo Berge	Master’s Thesis	2025
74	Türkiye’de Kültür Bakanlığına Bağlı Türk Halk Müziği Topluluklarında Bulunan Dilsiz Kaval İcracılarının Yöre Özelliklerine Göre İcra Görüşleri (Performance Perspectives of Rim-Blown Kaval Performers in Turkish Folk Music Ensembles Affiliated with the Ministry of Culture in Türkiye according to Regional Characteristics)	Ferhat Çelik	Master’s Thesis	2025
75	Dilsiz Kavalda Transpozisyon Üzerine PaR (Practice as Research) Temelli Bir Değerlendirme (A Practice-as-Research [PaR]-Based Evaluation of Transposition on the Rim-Blown Kaval)	Cuma Agpunar	Master’s Thesis	2025

76	Dilsiz Kaval Eğitiminde Kullanılan Birinci ve İkinci Perde Sistemleriyle İlgili Bir Karşılaştırmalı Durum Araştırması (A Comparative Case Study of the First and Second Finger-Hole Systems Used in Rim-Blown Kaval Education)	Serkan Ertürk	Doctoral Dissertation	2025
77	Adıyaman'da Zurna ile İcra Edilen Geleneksel Halk Oyunlarının Dilsiz Çoban Kavalı ile İcrasına Yönelik Tespitler (Findings on the Performance of Traditional Folk Dances Played on the Zurna in Adıyaman Using the Rim-Blown Shepherd's Kaval)	Mehmet Gazi Bilgiç	Master's Thesis	2025
78	Kaval Eğitiminde Ölçme Değerlendirme Kriterlerinin Belirlenmesi: Tam Yapılandırılmış Görüşmelerle Bir Durum Analizi (Determining Measurement and Evaluation Criteria in Kaval Education: A Case Analysis Based on Fully Structured Interviews)	Aytunç Aydın, Oğuz Yılmaz	Article	2025
79	Bulgaristan'da Komünizm Dönemi Halk Müziği Ortamları: Ulusal Kimlik İnşası ve İdeolojik Yönelimli Kültür Politikaları Bağlamında Kaval Çalgısının İkili Rolü (Folk Music Environments during the Communist Period in Bulgaria: The Dual Role of the Kaval in the Context of National Identity Construction and Ideologically Oriented Cultural Policies)	Batuhan Aydın	Master's Thesis	2025
80	21. Yüzyılda Türkiye'de Kadın Kaval İcracıları: İcra Biçimleri, Deneyimler ve Görünürlük (Female Kaval Performers in 21st-Century Türkiye: Performance Practices, Experiences, and Visibility)	Amine Bilen	Master's Thesis	2025
81	Dilsiz Kaval Çalgısında Kullanılan Birinci ve İkinci Perde Sistemleriyle İlgili Performans Kıyaslaması (A Performance Comparison of the First and Second Finger-Hole Systems Used on the Rim-Blown Kaval)	Serkan Ertürk, Atilla Özdek	Article	2025
82	Dilsiz Çoban Kavalının Tarihsel Süreçte Gelişimi ve Çalım Tekniklerinin İncelenmesi (An Examination of the Historical Development and Performance Techniques of the Rim-Blown Shepherd's Kaval)	Kemal Akdemir	Proficiency in Art Thesis	2025
83	Kaval Metodu (Dilli) (Kaval Method [Duct-Flute])	Temel Hakkı Karahasan	Method	?
84	Kaval Eğitim Metodu – Kaval Çalmayı Öğreniyorum Dilsiz – VCD (Kaval Education Method – I Am Learning to Play the Rim-Blown Kaval – VCD)	Salih Sütöğlu	VCD Method (No Written Document)	?

As shown in the table, a total of 83 academic studies across eight different study types were identified, comprising 1 symposium, 9 method studies, 4 proficiency-in-art theses, 3 doctoral dissertations, 28 master's theses, 23 articles, 1 opinion paper, 14 symposium papers, and 1 study (No. 22) whose type could not be determined.

Of these studies, 35 were identified through the National Thesis Center. Nine studies were retrieved from the proceedings of the 1st International Kaval Symposium, while 15 were identified through the bibliographic study presented by Atilla Özdek at the 1st International Kaval Symposium. Of the remaining 24 studies, 11 were retrieved from DergiPark and 14 from online academic sources such as Google Scholar.

Studies No. 10 and 13, identified through the National Thesis Center, could not be accessed in full text. Based on the findings, the type of study No. 22 could not be determined. The publication years of studies No. 83 and 84 could not be definitively established. Considering the studies presented in the table, Assoc. Prof. Dr. Aytunç Aydın was identified as the most prolific researcher, with one master's thesis, one doctoral dissertation, two method studies, and five articles. Distribution of Academic Studies on the Kaval by Year For this sub-problem, the data were evaluated by year, and the findings are presented in Table 2.

Table 2. Distribution of studies on the kaval instrument by year between 1942 and 2025

Year	MT		DD		PAT		CP		A		S		M		OP		Total	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
1942	-	-	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	1	1.23
1962	-	-	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	1	1.23
1984	-	-	-	-	-	-	-	-	-	-	-	-	1	14.28	-	-	1	1.23
1986	-	-	-	-	-	-	1	7.14	-	-	-	-	-	-	-	-	1	1.23
1988	-	-	-	-	-	-	-	-	-	-	-	-	1	14.28	-	-	1	1.23
1990	-	-	-	-	-	-	-	-	-	-	-	-	1	14.28	-	-	1	1.23
1991	-	-	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	1	1.23
1997	-	-	-	-	-	-	1	7.14	1	4.34	-	-	-	-	-	-	2	2.46
2000	1	3.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1.23
2003	-	-	-	-	-	-	-	-	-	-	-	-	1	14.28	-	-	1	1.23
2005	-	-	-	-	-	-	1	7.14	-	-	-	-	-	-	-	-	1	1.23
2006	2	7.14	-	-	1	25	-	-	-	-	-	-	-	-	-	-	3	3.69
2007	-	-	-	-	-	-	1	7.14	1	4.34	-	-	-	-	-	-	2	2.46
2011	-	-	-	-	-	-	-	-	1	4.34	-	-	1	14.28	-	-	2	2.46
2012	-	-	-	-	-	-	1	7.14	-	-	-	-	-	-	-	-	1	1.23
2013	-	-	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	1	1.23
2014	-	-	-	-	-	-	9	64.26	2	8.69	1	100	-	-	1	100	13	15.99
2015	1	3.57	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	2	2.46
2017	3	10.71	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	4	4.92
2018	-	-	-	-	-	-	-	-	1	4.34	-	-	-	-	-	-	1	1.23
2019	4	14.28	-	-	-	-	-	-	2	8.69	-	-	-	-	-	-	5	6.15
2020	1	3.57	1	33.33	1	25	-	-	1	4.34	-	-	-	-	-	-	4	4.92
2021	6	21.42	-	-	-	-	-	-	3	13.02	-	-	1	14.28	-	-	10	12.30
2022	1	3.57	1	33.33	-	-	-	-	-	-	-	-	-	-	-	-	2	2.46
2023	1	3.57	-	-	1	25	-	-	-	-	-	-	-	-	-	-	2	2.46
2024	2	7.14	-	-	-	-	-	-	1	4.34	-	-	1	14.28	-	-	4	4.92
2025	6	21.42	1	33.33	1	25	-	-	4	17.36	-	-	-	-	-	-	12	14.76
Total	28	100	3	100	4	100	14	100	23	100	1	100	7	100	1	100	81	100

MT: Master Thesis DD: Doctoral Dissertation PAT: Proficiency in Art Thesis CP: Conference Paper A: Article S: Symposium M: Method OP: Opinion Paper

According to Table 2, the academic studies can be ranked from the most to the least frequent as follows: master's theses, articles, conference papers, method studies, proficiency-in-art theses, doctoral dissertations, opinion papers, and symposiums. Studies No. 22, 83, and 84 in Table 1 were excluded from the analysis of the second sub-problem because of insufficient data. As shown in Table 2, 2014 was the year with the highest number of studies, with a total of 13 studies comprising 9 conference papers, 1 symposium, 1 opinion paper, and 2 articles. The highest number of master's theses was produced in 2021 and 2026, while the highest number of conference papers was recorded in 2014 with 9 studies, and the highest number of articles was recorded in 2025 with 4 studies. According to Table 2, no theses were produced between 1942 and 1999 (the twentieth century). During this period, a total of 7 studies were conducted, comprising 2 conference papers, 4 articles, and 3 method studies. Between 2000 and 2025 (the twenty-first century), a total of 73 academic studies were identified, comprising 28 master's theses, 3 doctoral dissertations, 4 proficiency-in-art theses, 12 conference papers, 1 opinion paper, 1 symposium, 19 articles, and 4 method studies.

Distribution of Academic Studies on the Kaval by Subject and Type

In this section, the studies were classified according to their subject areas and study types. This classification is presented in Table 3, followed by an interpretation of the findings.

Table 3. Classification of academic studies on the kaval by subject and type

	MT	%	DD	%	PAT	%	CP	%	A	%	OP	%	M	%	Total	%
Organology	1	3.57	-	-	-	-	1	7.14	2	8.68	-	-	-	-	4	4.80
General Review and Analysis	-	-	1	33.33	-	-	6	42.84	7	30.38	1	-	-	-	15	18
Historical Development and Process	2	7.14	-	-	2	50	-	-	1	4.34	-	-	-	-	5	6
Education	8	28.56	1	33.33	-	-	1	7.14	3	13.02	-	-	-	-	13	15.60
Performance Techniques	12	42.84	-	-	1	25	5	35.70	6	26.04	-	-	-	-	24	27.60
Methodology	1	3.57	-	-	1	25	1	7.14	3	13.02	-	-	9	100	15	18
Technology	2	7.14	-	-	-	-	-	-	-	-	-	-	-	-	2	2.40
Biography	2	7.14	1	33.33	-	-	-	-	1	4.34	-	-	-	-	4	4.80
Total	28	100	3	100	4	100	14	100	23	100	1	100	9	100	83	100

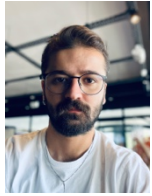
MT: Master Thesis DD: Doctoral Dissertation PAT: Proficiency in Art Thesis CP: Conference Paper A: Article S: Symposium M: Method OP: Opinion Paper

The data in the table reveal a clear hierarchy in the distribution of studies on the kaval across subject areas. Performance techniques constitute the most extensively studied area, with 24 studies. This category is followed by methodology and general review and analysis, with 15 studies each. Education, organology, and biography are represented by relatively fewer studies. Technology ranks last as the least frequently studied subject area in the existing literature. Accordingly, the findings indicate that performance techniques constitute the most extensively investigated subject area in the literature on the kaval, whereas technology-oriented studies represent the least investigated area. When the classification by study type is examined, master's theses predominantly focus on performance techniques, whereas proficiency-in-art theses primarily emphasize historical development and process. Conference papers and articles primarily address the subject within the framework of general review and analysis, whereas methodology is the dominant category among method studies. Similarly, opinion papers adopt a general review and analysis approach. Regarding doctoral dissertations, one study was identified in each of the categories of education, general review and analysis, and biography. In contrast, only one study was identified under the category of opinion papers. With regard to the least frequently addressed subjects by study type, organology and methodology are represented by only a limited number of master's theses, while performance techniques and methodology are represented by a limited number of proficiency-in-art theses. Among conference papers, organology, education, and methodology are the least frequently addressed subjects, whereas historical development and process and biography are among the least frequently examined subjects in articles. No master's thesis was identified under the category of general review and analysis. Among doctoral dissertations, no studies were identified in the categories of organology, historical development and process, performance techniques, methodology, or technology. Among proficiency-in-art theses, no studies were identified in the categories of organology, general review and analysis, education, technology, or biography. Conference papers did not address historical development and process, technology, or biography. Similarly, no article addressing technology was identified.

Conclusion and Recommendations

The fact that only 83 studies directly focusing on the kaval instrument were identified over an 83-year period is considered a noteworthy finding. Nevertheless, the overall distribution of studies, particularly those conducted in recent years, indicates a quantitative increase. A detailed examination of the tables shows that a substantial proportion of the studies concentrate on performance techniques and education, followed by studies involving general review and analysis. However, in the current technological era, the extremely limited number of technology-oriented studies on the kaval may be regarded as a significant academic gap and a disappointing aspect of the field. In addition, the absence of any patented work related to the kaval to date indicates that this gap persists not only at the theoretical level but also in terms of practical applications and innovation. In this context, it is important for all relevant stakeholders, particularly TRT Folk Music Choirs, folk music field researchers, social science specialists, and prospective academics, to undertake more specific, interdisciplinary, and internationally relevant studies. In particular, existing topics should be revisited in light of changing social and academic conditions and technological, societal, and scientific transformations, adopting more original and critical perspectives. It may therefore be concluded that more intensive and systematically planned research initiatives supported by relevant institutions are needed to establish a sustainable and effective academic foundation for future kaval studies. This section should be discussed with reference to the relevant literature. Rather than being presented as an extended summary of the findings, the results should be interpreted and discussed in relation to previous studies.

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https://upload.wikimedia.org/wikipedia/commons/a/a6/Divje_Babe_flute_%28Late_Pleistocene_flute%29.jpg

Research Article

Effects of peg systems on structural vibration and acoustic response in an oud

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Abstract

Peg systems form part of the mechanical structure of a stringed instrument, but their contribution to the oud's response has received limited experimental attention. This exploratory pilot study compared four conditions on one unstrung oud: No Pegs, Rosewood Pegs, Ebony Pegs, and Wittner Mechanical Pegs. Impact-based frequency-response measurements combined bridge and neck-pegbox vibration with force-normalized acoustic response. Three resonance regions selected by qualitative screening of the broadband spectra, labelled Mode 1–Mode 3 for this comparison, were tracked at a frequency increment of 1.5625 Hz. Of these three regions, Mode 3 showed the largest frequency shifts. Relative to No Pegs, the Wittner condition shifted the bridge peak downward by 10.94 Hz and increased the bridge, neck-pegbox, and acoustic peak levels by 2.51, 11.18, and 5.39 dB, respectively. Mode 2 showed contrasting bridge and neck responses, while acoustic changes were not consistently monotonic across conditions. At the evaluated frequencies, coherence was high for the No Pegs neck and Ebony bridge records and lower for the No Pegs and Rosewood acoustic records; no acoustic coherence was recorded for Ebony or Wittner. The results identify mode-dependent changes associated with peg-system substitution and support examining the pegbox within the coupled body-neck structure. This single-instrument comparison does not isolate mass from other mechanical differences or establish tonal superiority under playing conditions.

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Introduction

A stringed instrument responds through the interaction of its body, neck, and attached components, rather than through the soundboard alone. Bridge motion links the vibrating strings to this distributed structure and to the enclosed air (Woodhouse, 2004). In violin studies, geometry and material properties are related to the spatial distribution of mass and stiffness and, in turn, to modal frequencies and vibration patterns (Schleske, 2002a). This perspective makes a component remote from the main radiating surface a legitimate subject of structural investigation.

The mechanical importance of a local mass change depends on where it acts within a vibration pattern. Roohnia (2026) examined this dependence using added masses and material removal at selected positions on wooden beams: mass loading near antinodal regions generally lowered natural frequencies more than loading near nodes. Material removal also changed stiffness, illustrating why a component modification cannot always be reduced to its mass difference. Modal mass is not simply the weighed mass of an attached component; its value depends on the mode shape and its normalization (Ewins, 2000). Consequently, peg-set mass can characterize an experimental condition without uniquely predicting its resonance response.

Neck and terminal components provide relevant precedents, although the evidence comes from different instruments and interventions. Experimental modal analysis of a violin identified neck-fingerboard bending and coupled motion involving the corpus (Marshall, 1985). Schleske (2002b) explicitly related the violin neck-fingerboard

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bending resonance to neck stiffness and to the masses of the neck, scroll, and pegs. Neck shaping, equipment installation, and body assembly also alter the modal behaviour of electric guitars (Paté et al., 2015). Commercial headstock-mass accessories offer a practical motivation, but advertised sustain benefits are not experimental evidence for an oud (Fender Musical Instruments Corporation, n.d.). These precedents justify testing terminal components without assuming identical mechanisms across instrument families.

Structural response and acoustic output must also be distinguished. Modelling of a guitar resonance box shows that the soundboard, back, and enclosed air participate in coupled modes (Elejabarrieta et al., 2002). Schleske (2002a) contrasted weakly and strongly radiating violin modes and presented bridge mobility and pressure-to-force radiation responses as separate observables. A change at a local vibration measurement point therefore does not by itself establish a proportionate change in radiated sound.

Earlier oud research combined bridge mobility, acoustic response, and experimental modal shapes to investigate sound production (Değirmenli, 2023). That work identified both coincident spectral features and regions in which the relative prominence of the structural and acoustic responses differed. It provides an instrument-specific reason to examine the two responses together, but does not establish the effect of changing complete peg systems. Hollow-neck bağlama experiments offer a related structural–acoustic comparison; however, changing neck and cavity geometry is not equivalent to substituting tuning pegs (Şahinkaya et al., 2024). Brace–soundboard models likewise concern changes in combined mass and stiffness rather than an isolated terminal mass (Dumond & Baddour, 2012).

The remaining question is how real peg-system substitution is reflected in the responses measured at the bridge, near the neck–pegbox junction, and in the exterior acoustic response of an oud. This relationship remains insufficiently understood for the oud’s backward-angled, multi-peg structure. The present exploratory within-instrument pilot study addresses that question on one unstrung oud using No Pegs, Rosewood Pegs, Ebony Pegs, and Wittner Mechanical Pegs. It asks which tracked resonance regions are most sensitive, whether bridge and neck–pegbox changes have the same direction, and whether corresponding changes appear acoustically. Its contribution is a linked comparison of these observation areas for practical peg systems, not a causal calibration of total mass or a test of perceived sound quality.

Method

Experimental design

An exploratory within-instrument comparison was conducted on one oud under four conditions, presented throughout in ascending measured peg-set mass (Table 1). All strings were removed in every condition. This excluded differences in string tension and string vibration between conditions, but the results describe the structure without string-induced prestress rather than the instrument under playing conditions. No Pegs served as the experimental reference. Measurements were conducted on the same day, with sequential peg-system substitutions and no randomization of condition order. The ascending-mass order in Table 1 is the reporting order.

The oud had a Brazilian rosewood bowl and a cedar double-top soundboard. Its neck length was 195 mm and its nominal vibrating string length in the strung configuration was 585 mm. The latter is an instrument dimension, not a string length present during these unstrung measurements.

The mechanical system used WITTNER FINETUNE-PEGS, model 270111S. The manufacturer lists this model for 4/4–3/4 violin, with a nominal diameter at the ring of 7.8 mm and a taper of 1:30 (Wittner, n.d.); it was used on the oud in this experiment. These catalogue dimensions identify the product and are not measurements of its installed fit in this pegbox.

Each of the three photographed installed sets comprised eleven pegs (Figure 1). The No Pegs arrangement is shown in Figure 2a. All peg systems had been fitted to the pegbox before the measurement sequence. Substitution involved insertion and removal only, without further shaping or fitting during acquisition. The wooden pegs seated through their conical friction fit. The oud remained in the fixture throughout all substitutions.

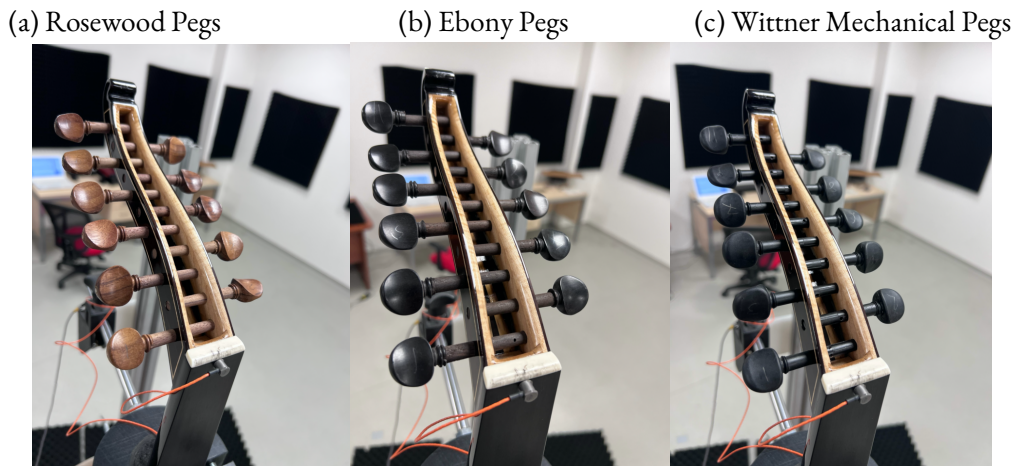


Figure 1. Installed peg sets in increasing measured set-mass order: (a) Rosewood Pegs, (b) Ebony Pegs, and (c) Wittner Mechanical Pegs. Each set contains eleven pegs. The neck sensor and its cable are visible below the nut. Photographs supplied by the author; the views are not to a common spatial scale. The No Pegs condition is shown in Figure 2a.

Group A denotes the structural measurements of bridge and neck–pegbox responses; Group B denotes the structural–acoustic measurements of bridge and microphone responses. Both groups include all four peg conditions. The letters identify acquisition datasets, not different peg systems or instruments. Group A measurements were completed for all four conditions before Group B began. The peg sets were reinstalled for Group B; thus, the A and B records for a given set were not consecutive measurements with the pegs left untouched. The oud remained on its supports and all sensors remained attached during these changes.

Table 1. Measured peg-set masses and acquisition averaging counts.

Condition	Set mass (g)	Group A bridge and neck	Group B bridge	Group B microphone
No Pegs	0.0	5	5	36
Rosewood Pegs	38.0	5	5	36
Ebony Pegs	54.0	5	5	36
Wittner Mechanical Pegs	112.5	5	5	36

The 0 g entry refers only to the absence of the peg set. The installed systems also differ in material, mass distribution, mechanism, and contact conditions. Their measured differences cannot be assigned to total mass alone. Masses were measured with a calibrated laboratory balance. For every peg condition, all accelerometer-based bridge and neck–pegbox FRFs used five impact averages, including the bridge records in both Groups A and B. All microphone-based acoustic FRFs used 36 impact averages (Table 1). Analyzer averages improve spectral estimation and are not independent experimental replicates.

Measurements and response quantities

The measurement chain comprised a Brüel & Kjær Type 8204 miniature impact hammer, Type 3050-A-060 six-channel LAN-XI module, Type 4517 miniature accelerometer near the bridge, and Type 4189-A-021 microphone set. An additional Type 4516 accelerometer was positioned near the end of the neck adjacent to the pegbox. The microphone and impact hammer were calibrated. In Group A, the force reference and both acceleration channels were acquired simultaneously, providing paired bridge and neck–pegbox responses with five impact averages. In Group B, the bridge acceleration and microphone channels were acquired concurrently with the force reference, providing structural and acoustic responses processed by separate averaging analyzers: five impacts for the bridge response and 36 for the acoustic response. Bridge (Group A) and Bridge (Group B) refer to the two measurement stages, separated by peg-set reinstallation, using the same bridge-region accelerometer at the same location. Neck–pegbox denotes the single neck-sensor location adjacent to the pegbox, not two measurement sites. The retained Group A and Group B spectra were analysed separately.

Complex H1 frequency-response functions (FRFs) were acquired in PULSE LabShop 20.0.0.455 using FFT spectrum averaging and uniform force and response windows. The exported spectra covered 0–10 kHz with 6401 points including zero, a 1.5625 Hz frequency increment, and a 0.64 s record length. The averaging counts were identical across

peg conditions within each response type: five impacts for every accelerometer-based FRF and 36 for every microphone-based FRF (Table 1).

Measurements were made in a room 11 m long and 7.5 m wide, with a ceiling height of 2.85 m. The setup centre was 3.2 m from the short wall shown on the left of the plan and centred across the room width (Supplementary Fig. S3). No separate acoustic characterization of the room was performed.

For acoustic acquisition, the oud and microphone were rotated together through 36 room orientations at 10° increments. The microphone remained 1 m from the soundboard along the normal through the midpoint between the two small sound holes, with its position relative to the oud unchanged. In PULSE, linear spectrum averaging was applied over 36 impact records, one at each room orientation: the force autospectrum and complex force–pressure cross-spectrum were each averaged in the linear spectral domain with equal record weights, and H1 was calculated from the ratio of these averaged spectra. Acoustic levels were obtained from the magnitude of the resulting complex H1, followed by conversion to dB re 1 Pa/N. Individual FRF magnitudes or dB values were not arithmetically averaged. Each peg condition was therefore represented by one force-normalized acoustic spectrum, compared through its spectral shape and the selected frequencies and levels. The joint rotation was intended to reduce room-mode contributions and followed the geometric arrangement described by Schleske (2002b, p. 43). This spectral estimator is not equivalent to Schleske’s energy averaging of transfer responses. The assembly sampled a fixed direction relative to the instrument, not different radiation directions, and did not measure total acoustic power. Orientation-resolved spectra were not retained, so residual room contributions and the effect of the averaging operator could not be evaluated retrospectively.

The oud was held upright on a graduated rotary base (Figure 2a–b). The neck restraint made light contact through a rubber piece, and elastic rubber bands supported the lower bowl. The oud was not removed from these supports during peg substitutions. During rotation, the instrument, supports, sensors, and microphone retained their relative positions. Both accelerometers were attached with beeswax formulated for accelerometer mounting, with their sensing directions normal to the soundboard. All sensors remained attached throughout the experiment, including the Type 4516 during acoustic acquisition and whenever its response was not being recorded. The Type 4516 was on the fingerboard immediately below the nut (Figure 2d); the bridge-region sensor and impact mechanism are shown in Figure 2c.

The miniature hammer had a metal tip and was operated as a pendulum to avoid double impacts. It was released from the same position for successive impacts and struck the bass side of the bridge normal to the soundboard surface. The impact location and direction were unchanged across peg conditions. A waiting interval was allowed between successive impacts for the response to decay. Although the Group B channels were acquired concurrently, their retained bridge and microphone FRFs represent different averaging populations rather than matched averages over the same set of impacts. The individual impact indices contributing to the five-impact bridge average were not retained. The retained Group A and Group B bridge spectra were therefore compared separately rather than pooled.

The raw complex acceleration-to-force response (accelerance, in $\text{m}/(\text{N}\cdot\text{s}^2)$) was preserved and converted to velocity-to-force mobility at nonzero frequencies. The microphone response remained a sound-pressure-to-force FRF:

$$Y(f) = H_a(f)/(i2\pi f), \quad H_a(f) = a(f)/F(f), \quad H_p(f) = p(f)/F(f).$$

Here, f is frequency, i is the imaginary unit, and a , F , and p denote acceleration, force, and sound pressure. Mobility is expressed in $\text{m}/(\text{N}\cdot\text{s})$, and acoustic FRF magnitude in Pa/N . Bridge mobility denotes the near-bridge transfer response; exact coincidence of the excitation and observation points was not established. The neck–pegbox channel is likewise a transfer response to bridge force, not a neck driving-point measurement.

FRF levels were calculated as $20 \log_{10}$ of magnitude relative to $1 \text{ m}/(\text{N}\cdot\text{s})$ for mobility and $1 \text{ Pa}/\text{N}$ for the acoustic response. Acoustic FRF level is therefore not sound pressure level. No A-weighting or spectral smoothing was applied. Peak-frequency and level differences, Δf and ΔL , were defined relative to No Pegs within each group. These comparisons use each condition’s own selected frequency and do not represent fixed-frequency gain. No significance tests or fitted causal models were applied.

The archived data used for this analysis comprise 16 complex FRF exports and four coherence exports. The reanalysis selected the largest sampled magnitude in each inclusive search window on the original FFT grid; an exact tie would select the lower-frequency bin. No sub-bin peak fit was applied. At a selected Group A bridge frequency, the neck/bridge ratio uses the two magnitudes at that same FFT bin, not the ratio of separately selected peaks.

Individual impact time histories, orientation-resolved acoustic spectra, and systematic independent installation-repeat records were not available in the analysed archive. Consequently, impact-to-impact variance, installation-related uncertainty, and the adequacy of decay within the 0.64 s uniform window could not be quantified retrospectively. The frequency increment is a sampling interval, not a confidence interval or a complete measurement uncertainty.

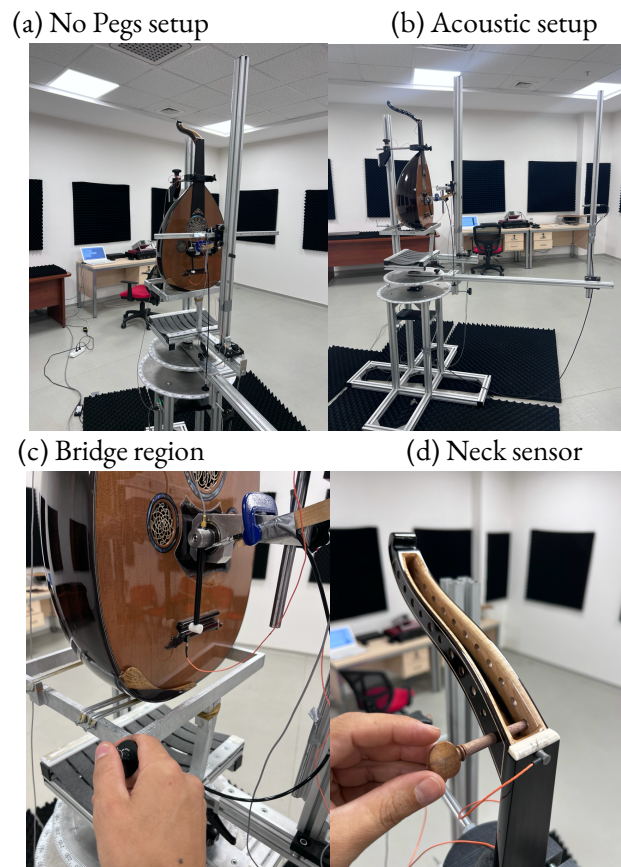


Figure 2. Photographic documentation of the experimental arrangement. (a) The unstrung oud without pegs in the upright fixture, including the lightly contacting rubber neck restraint, elastic rubber support beneath the bowl, and graduated rotary base. (b) The instrument and microphone on the shared rotary assembly. (c) The pendulum impact mechanism, bridge-region accelerometer, and lower-bowl support. (d) The Type 4516 sensor immediately below the nut during installation of a rosewood peg; this panel is not a photograph of the No Pegs measurement condition. Photographs supplied by the author; panel views are not to a common spatial scale.

Resonance tracking and measurement quality

Mode 1–Mode 3 designate three prominent resonance regions tracked in this comparison; they do not denote the complete ordering of the instrument's natural modes or a standard (m,n) nodal classification. The search windows were 200–220, 225–245, and 260–300 Hz, respectively. Selection followed an initial examination of the 0–10 kHz spectra and a more detailed comparison over 0–1 kHz. Changes in resonance position, peak level, and spectral shape across peg conditions identified these three characteristic low-frequency regions as showing particularly pronounced responses to peg-system substitution. Detailed tracking was then concentrated on these regions (Supplementary Figs. S1 and S2). This was qualitative spectral screening, not a calculated sensitivity coefficient, a statistical selection test, or a preregistered ranking of all resonances. The associated mass differences were not isolated from the other mechanical differences between peg systems. Figure 3 presents three vibration patterns adapted from Değirmenli (2023, Figure 1, p. 527), labelled Mode 1, Mode 2, and Mode 3 from left to right to provide spatial context for the tracked regions. These patterns belong to the earlier study and do not validate current mode shapes across peg conditions.

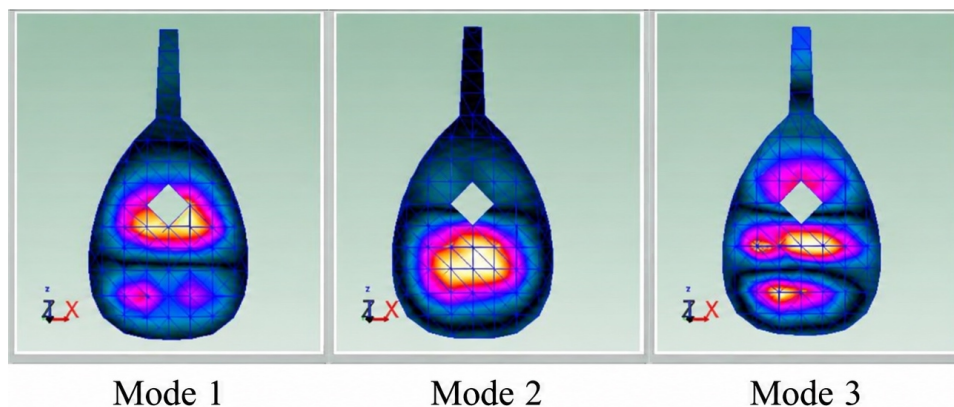


Figure 3. Oud vibration patterns adapted from Değirmenli (2023, Figure 1, p. 527; oud no. 2 in that study), labelled Mode 1, Mode 2, and Mode 3 from left to right. The patterns provide spatial context from the earlier study; they are not mode shapes measured in the present experiment and do not establish current phase or nodal lines.

The historical illustration provides qualitative spatial context only. The excerpt contains no quantitative colour key, so colour intensities are not compared as calibrated displacement, phase, or radiation efficiency between panels. Matching the present peaks to those historical mode shapes has not been independently demonstrated.

Within each window, maxima were obtained from the unsmoothed numerical spectra without sub-bin interpolation. Mode 1 did not exhibit a distinct acoustic peak. Its microphone magnitude was therefore sampled at the corresponding Group B bridge-peak frequency, with no independent acoustic Δf assigned. Mode 2 acoustic values represent band maxima among neighbouring local peaks. Mode 3 provided the clearest structural–acoustic correspondence. Coherence was assessed over 0–1000 Hz and at the corresponding FRF-derived evaluation frequencies for the four measured channel–condition combinations (Figure 7; Supplementary Table S1). These measurements provide local quality information only; they do not establish reliability for unmeasured channel–condition combinations.

Results

Mode dependent structural and acoustic changes

Figure 4 places the selected windows in the 100–1000 Hz responses, including the Group B bridge spectra. Shading identifies the three analysis windows without implying that other resonances are absent or less sensitive. Supplementary Fig. S1 shows the full acquired bandwidth, and Supplementary Fig. S2 extends the low-frequency overview below 100 Hz to document the spectral context of the screening.

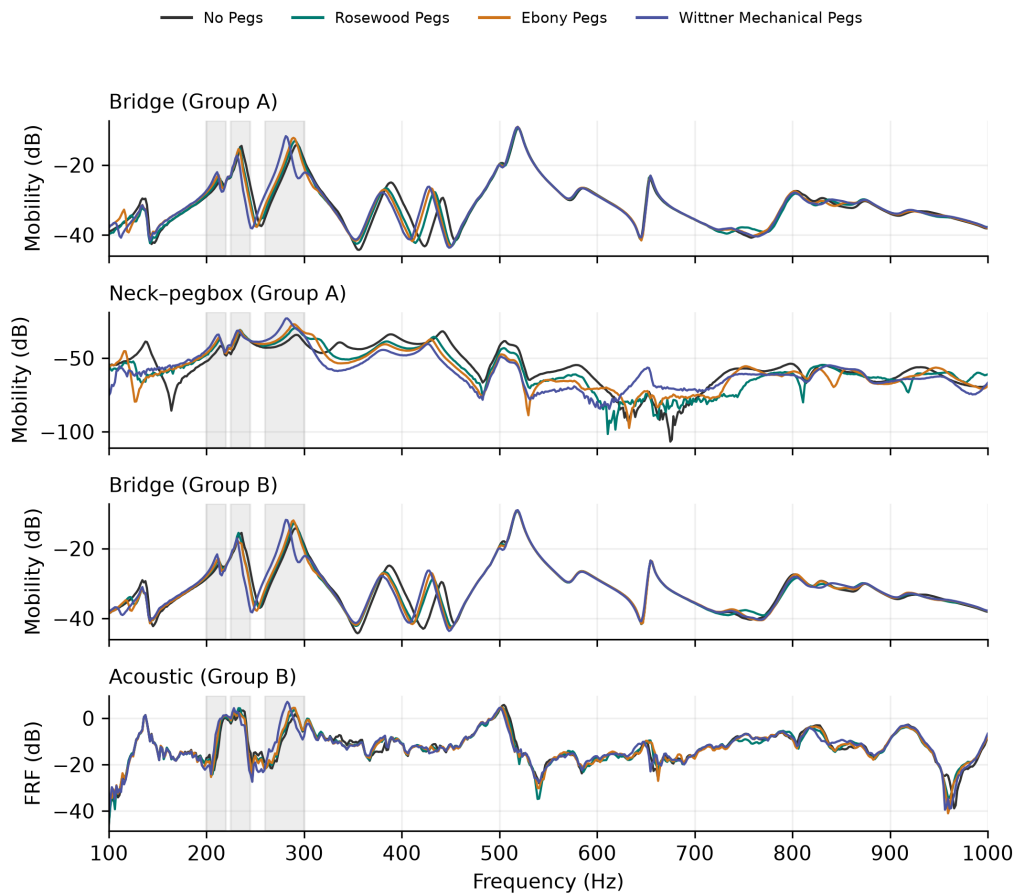


Figure 4. Unsmoothed responses from 100–1000 Hz. The rows show Group A bridge and neck–pegbox mobility, Group B bridge mobility, and Group B acoustic FRF. Mobility levels are relative to 1 m/(N·s), and acoustic levels to 1 Pa/N. Shaded windows are Mode 1 (200–220 Hz), Mode 2 (225–245 Hz), and Mode 3 (260–300 Hz). Group A is the structural dataset (bridge and neck–pegbox), and Group B is the structural–acoustic dataset (bridge and microphone). The bridge traces in the two groups come from the same sensor location in separate acquisitions; structural and acoustic averaging counts differ as specified in Table 1.

The response to peg-system substitution depended on the resonance region. Figure 5 resolves the three tracked regions. Tables 2 and 3 bring together the frequencies, levels, and changes relative to the reference. Structural Mode 3 had the largest frequency shift. Across the reporting sequence, Modes 1 and 3 increased in both bridge and neck–pegbox peak level; Mode 2 instead showed contrasting changes at the two structural observation points.

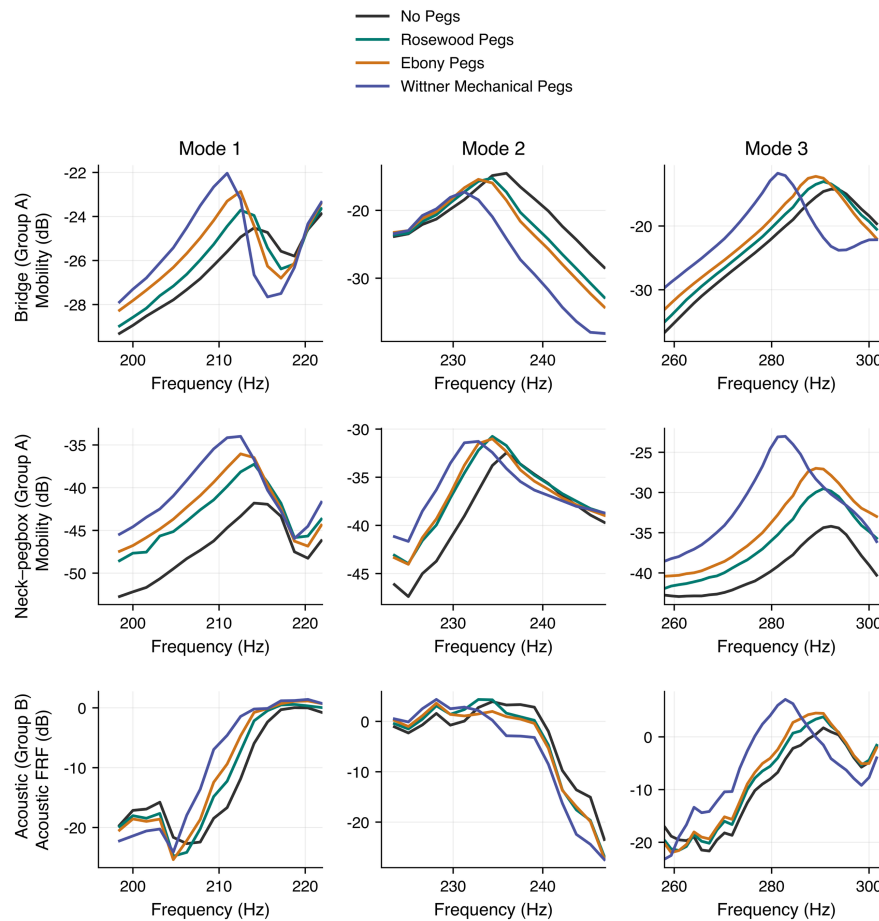


Figure 5. Responses in Mode 1–Mode 3. Columns identify resonance regions; rows show Group A bridge mobility, Group A neck–pegbox mobility, and Group B acoustic FRF. References are 1 m/(N·s) for mobility and 1 Pa/N for acoustic response. Vertical scales differ between panels. The Mode 1 microphone shoulder is not treated as an independent peak; neighbouring maxima remain visible in Mode 2. Group A denotes the paired structural measurements; Group B denotes the structural–acoustic measurements. Acoustic FRF refers to microphone pressure normalized by bridge input force.

For Mode 1, the bridge peak shifted by -3.13 Hz from No Pegs to Wittner, equivalent to two FFT bins. Bridge and neck–pegbox peak levels increased by 2.48 and 7.81 dB, respectively. The same-frequency neck/bridge magnitude ratio increased from 0.137 to 0.248. The acoustic samples followed a different sequence: Rosewood Pegs were 1.27 dB below No Pegs, while Ebony and Wittner were approximately 1.3 dB above it. These samples did not resolve a corresponding independent acoustic resonance.

Table 2. Selected frequencies and FRF levels for the three observation areas

M	Peg condition	Bridge (Group A) f (Hz); L (dB)	Neck–pegbox (Group A) f (Hz); L (dB)	Acoustic (Group B) f (Hz); L (dB)
1	No Pegs	214.06; -24.52	214.06; -41.80	214.06*; -5.94
1	Rosewood Pegs	212.50; -23.71	214.06; -37.25	212.50*; -7.22
1	Ebony Pegs	212.50; -22.87	212.50; -36.04	212.50*; -4.67
1	Wittner Mechanical Pegs	210.94; -22.04	212.50; -33.99	210.94*; -4.60
2	No Pegs	235.94; -14.53	235.94; -32.47	234.38; 3.92
2	Rosewood Pegs	234.38; -15.23	234.38; -30.76	232.81; 4.35
2	Ebony Pegs	232.81; -15.43	234.38; -31.01	228.13; 3.60
2	Wittner Mechanical Pegs	231.25; -17.29	232.81; -31.28	228.13; 4.36
3	No Pegs	292.19; -14.23	292.19; -34.20	290.63; 1.71
3	Rosewood Pegs	290.63; -13.03	290.63; -29.52	290.63; 3.81
3	Ebony Pegs	289.06; -12.21	289.06; -27.00	289.06; 4.51
3	Wittner Mechanical Pegs	281.25; -11.72	282.81; -23.02	282.81; 7.10

Note. **M**: Mode, Each cell reports frequency followed by level. Level references are 1 m/(N·s) for mobility and 1 Pa/N for acoustic FRF. *Acoustic Mode 1 is sampled at the Group B bridge-peak frequency, not at an independent acoustic maximum. Mode 2 acoustic values are band maxima. Decimal display does not imply finer resolution than 1.5625 Hz. Group A contains the paired bridge and neck–pegbox records; Group B contains the bridge and microphone records. Acoustic (Group B) denotes the force-normalized microphone response.

Mode 2 contrasted with Modes 1 and 3. From No Pegs to Wittner, the Group A bridge peak moved downward by 4.69 Hz and its level decreased by 2.76 dB. Nevertheless, every installed peg system had a higher neck–pegbox peak level than No Pegs; among those three systems, the neck level decreased slightly. The acoustic band-maximum levels were non-monotonic and did not follow the bridge decrease. For Ebony and Wittner, the dominant microphone maximum lay on the lower-frequency side of the window. This change in the selected maximum does not establish a continuous shift of the same acoustic pole.

Mode 3 showed the clearest correspondence across the observation areas. From No Pegs to Wittner, the bridge, neck–pegbox, and acoustic maxima shifted downward by 10.94, 9.38, and 7.81 Hz, respectively, while their peak levels increased by 2.51, 11.18, and 5.39 dB. At each Group A bridge-peak frequency, the neck/bridge magnitude ratio increased from 0.100 to 0.270. Both the absolute neck peak level and its response relative to the bridge therefore increased. The largest mass increment did not yield the largest level increment in every response. Because mass was not varied independently of peg-system construction and contact conditions, these observations do not identify a mass-only gain relationship or exclude other possible mass-dependent models.

Table 3. Changes relative to No Pegs within each resonance region.

M	Peg condition	Bridge (Group A) Δf (Hz); ΔL (dB)	Neck–pegbox (Group A) Δf (Hz); ΔL (dB)	Acoustic (Group B) Δf (Hz); ΔL (dB)
1	Rosewood Pegs	–1.56; +0.81	0.00; +4.55	—; –1.27
1	Ebony Pegs	–1.56; +1.66	–1.56; +5.76	—; +1.27
1	Wittner Mechanical Pegs	–3.13; +2.48	–1.56; +7.81	—; +1.35
2	Rosewood Pegs	–1.56; –0.70	–1.56; +1.71	–1.56; +0.43
2	Ebony Pegs	–3.13; –0.90	–1.56; +1.45	–6.25; –0.31
2	Wittner Mechanical Pegs	–4.69; –2.76	–3.13; +1.19	–6.25; +0.44
3	Rosewood Pegs	–1.56; +1.20	–1.56; +4.68	0.00; +2.10
3	Ebony Pegs	–3.13; +2.02	–3.13; +7.21	–1.56; +2.80
3	Wittner Mechanical Pegs	–10.94; +2.51	–9.38; +11.18	–7.81; +5.39

Note. **M:** Mode, No Pegs is the zero reference in every column. A dash indicates that no independent acoustic frequency shift was defined for Mode 1. Acoustic Mode 1 ΔL compares samples at condition-specific Group B bridge frequencies. Differences use unrounded source values.

Consistency and coherence

The Group A and Group B bridge spectra were generally close over 100–1000 Hz. In the reporting order, median absolute level differences were 0.33, 0.29, 0.15, and 0.06 dB. Mode 1 peak frequencies agreed between groups, and Mode 3 frequencies differed by no more than one bin. Mode 2 showed greater differences between stages. For Ebony, the selected bridge peak levels were –15.43 dB in Group A and –17.43 dB in Group B, giving $B - A = -2.00$ dB (Figure 6; Table 4). This compares each record's own selected bridge maximum, not microphone levels or a constant offset across the frequency band. The spectra were not pooled.

Relative comparisons used each group's own No Pegs reference. In Mode 2, the bridge-level changes for Rosewood, Ebony, and Wittner were –0.70, –0.90, and –2.76 dB in Group A, compared with +0.02, –1.91, and –1.56 dB in Group B, respectively, calculated from unrounded spectra. The Ebony–No Pegs contrast therefore changed by –1.01 dB between stages, rather than –2.00 dB, because the No Pegs level also changed. The magnitudes and ordering of the small Group A level changes were not fully preserved in Group B. The direction of the bridge-level decrease was retained for Ebony and Wittner, but not for Rosewood.

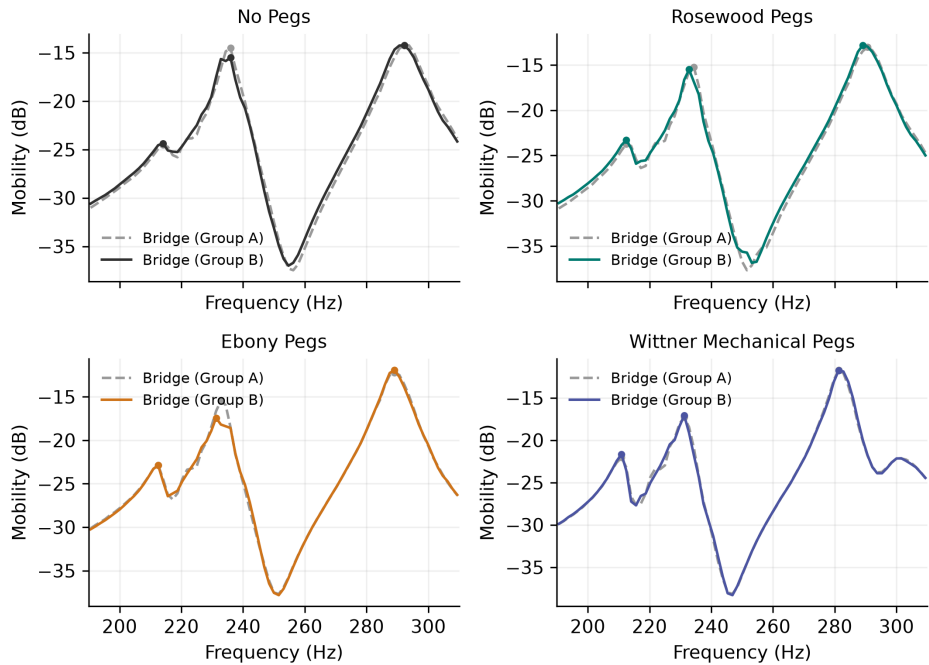


Figure 6. Group A and Group B bridge mobility over 190–310 Hz, separated by peg condition. Dashed grey lines indicate Group A and solid coloured lines Group B. Dots identify the selected FFT-bin maxima. Levels are relative to 1 m/(N.s). The peg sets were reinstalled between stages while the oud and sensors remained in place; these overlays are not a systematic installation-repeatability test.

Table 4. Group B bridge maxima and differences from Group A at each acquisition’s selected maximum. A and B identify the structural and structural–acoustic acquisition datasets, respectively; B – A is the between-dataset difference for the same bridge sensor location, not a comparison of different bridges. Peg sets were reinstalled between the two stages without removing the oud from its supports.

Mode	Peg condition	B f (Hz)	B level (dB)	B – A f (Hz)	B – A level (dB)
1	No Pegs	214.06	-24.37	+0.00	+0.15
1	Rosewood Pegs	212.50	-23.28	+0.00	+0.43
1	Ebony Pegs	212.50	-22.89	+0.00	-0.03
1	Wittner Mechanical Pegs	210.94	-21.66	+0.00	+0.37
2	No Pegs	235.94	-15.52	+0.00	-0.99
2	Rosewood Pegs	232.81	-15.50	-1.56	-0.27
2	Ebony Pegs	231.25	-17.43	-1.56	-2.00
2	Wittner Mechanical Pegs	231.25	-17.08	+0.00	+0.21
3	No Pegs	292.19	-14.25	+0.00	-0.02
3	Rosewood Pegs	289.06	-12.81	-1.56	+0.22
3	Ebony Pegs	289.06	-11.93	+0.00	+0.28
3	Wittner Mechanical Pegs	281.25	-11.79	+0.00	-0.06

Note. Each acquisition contributes its own selected peak. Level reference: 1 m/(N.s). Differences are between acquisitions, not uncertainty estimates. Differences were calculated from unrounded source values.

Figure 7 shows high structural coherence (>0.999) at the evaluated No Pegs neck and Ebony bridge peaks. Acoustic coherence was lower: at the Mode 3 peaks it was 0.720 for No Pegs and 0.745 for Rosewood, with minima of 0.204 and 0.153 elsewhere within the Mode 2 window. Thus, structural quality at these peaks was well supported, whereas the acoustic comparisons require greater caution. Frequency-specific values are provided in Supplementary Table S1; other channel–condition combinations were not measured.

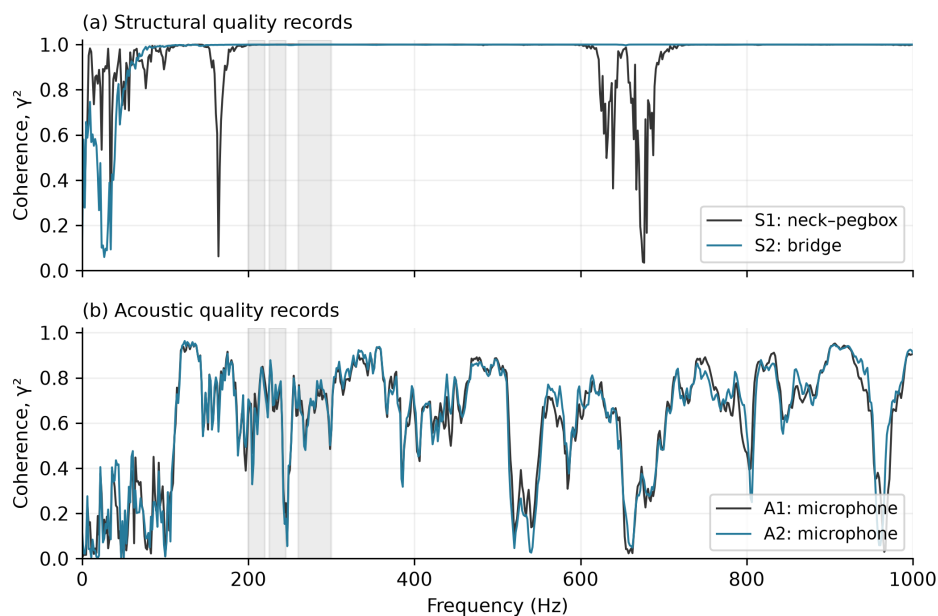


Figure 7. Coherence over 0–1000 Hz for the four acquired records. (a) S1: No Pegs neck–pegbox response, Group A; S2: Ebony bridge response, Group B. (b) A1: No Pegs microphone; A2: Rosewood microphone. Shaded bands indicate the three search windows. These records do not verify every channel and peg condition.

The low acoustic coherence may reflect low response magnitude, noise, or variation between room orientations; the retained data do not separate these contributions. Structural coherence cannot replace missing acoustic quality information. High coherence in an individual structural record does not demonstrate reproducibility after peg reinstallation.

Discussion

The comparison answers the research questions through a pattern of selective sensitivity, not a uniform response to increasing peg-set mass. Of the three selected regions, Mode 3 was the most frequency-sensitive and provided the clearest structural–acoustic correspondence. Mode 2 showed that the near-bridge and neck–pegbox responses need not change in the same direction, while Mode 1 did not provide an independently resolved acoustic peak. The peg-system comparison therefore concerns the distribution of response within a coupled instrument, rather than a single gain applied to all vibration and sound.

The downward structural-frequency shifts are compatible with a contribution from local inertia. Their unequal magnitudes across modes are also consistent with Roohnia’s (2026) position-dependent beam results. That analogy supplies a testable explanation, not a diagnosis: the present measurements do not show that the pegbox is an antinode of any tracked mode. Nor does weighing a peg set determine its effective modal contribution. Differences in mass distribution, contact behaviour, material, and mechanical construction remain inseparable here. In particular, substituting a geared mechanical system for wooden pegs is not equivalent to adding an inert mass while leaving the original assembly unchanged.

Peak levels require an explanation separate from frequency shifts. In a modal expansion, a transfer FRF combines contributions weighted by the mode-shape components at the excitation and response coordinates; its frequency dependence also includes modal stiffness, mass, and damping (Ewins, 2000). Thus, the increased relative neck response in Mode 3 and the bridge–neck contrast in Mode 2 could be associated with altered modal participation at the fixed sensors, damping changes, or contributions from neighbouring modes. The data do not separate these possibilities. The measured neck/bridge ratio describes relative local response; it is not a measure of vibration energy or a one-way transfer of energy from the pegbox to the bridge. The near-bridge and neck channels must likewise remain transfer responses, not be reinterpreted as exact driving-point mobilities.

The neighbouring acoustic maxima in Mode 2 warrant particular restraint. Schleske (2002b) showed that resonant coupling between a violin fingerboard mode and corpus motion can produce a split response. This provides one physical

reason why nearby peaks in an instrument need not behave as an isolated resonance. It does not establish mode splitting in the present spectra. The change in the dominant Mode 2 maximum may reflect altered relative contributions within the band, and peak selection alone cannot distinguish that explanation from a shift of a single modal pole. The between-stage bridge comparison also limits interpretation of the small Mode 2 level changes. Peg reinstallation may have altered seating and contact conditions, but the retained data cannot separate this possibility from other sources of between-stage variation. The -2.00 dB Ebony peak difference is not a general ± 2 dB uncertainty applicable to all channels or frequencies, nor a repeatability estimate from systematic independent installations. This local discrepancy qualifies the Mode 2 bridge-level ranking without invalidating the whole region or the findings in the other tracked regions.

The earlier modal image provides spatial context rather than a substitute for current mode-shape measurements. The pattern labelled Mode 1 shows coloured regions around and below the central sound hole, with additional lower-body regions, whereas the most prominent coloured area in Mode 2 lies further down the body. The pattern associated with Mode 3 contains several active regions across the upper, middle, and lower body. These observations connect the tracked regions to the earlier oud investigation (Değirmenli, 2023), but the static colours do not establish phase, current nodal lines, or pegbox displacement. The neck–pegbox accelerometer adds direct local response evidence in the present comparison; it does not validate full-field identity between the historical patterns and the current resonances.

The acoustic findings answer a different question from the mobility findings. Coupled cavity and structural motion can contribute differently to an exterior pressure response (Elejabarrieta et al., 2002), and the earlier oud study likewise documented differences in the relative prominence of mobility and acoustic features (Değirmenli, 2023). The coincident direction of the Mode 3 frequency and level changes supports a structural–acoustic association in that region; the other regions show why it should not be assumed generally. Bissinger's (2008) determination of violin radiation efficiency combined spatially sampled structural vibration with acoustic measurements surrounding the instrument. The present pressure-to-force response is therefore evidence about the measured acoustic transfer, not total radiated power or radiation efficiency. Rotating instrument and microphone together does not convert it into a directivity measurement.

The Mode 3 acoustic increase of 5.39 dB is a difference between selected FRF maxima for this observation geometry. Its interpretation remains provisional because acoustic coherence was recorded only for No Pegs and Rosewood, with no record for the Wittner response. It is not a validated increase in total sound power or a performance recommendation.

For instrument making, the defensible implication is that peg-system choice can be considered alongside the mechanical design of the neck and body, rather than solely as a tuning or ergonomic decision. This study locates response regions in which further testing is worthwhile while holding the instrument itself constant.

Conclusion

This pilot study compared four peg-system conditions on a single unstrung oud using bridge mobility, neck–pegbox vibration, and force-normalized acoustic measurements. The observed changes varied across the three selected resonance regions. Mode 3 exhibited the largest frequency shifts and the clearest corresponding acoustic change. In Mode 2, the Group A records showed opposite changes in bridge and neck–pegbox peak levels relative to the No Pegs condition, while Mode 1 showed structural changes without an independently resolved acoustic peak. These findings indicate that the response associated with peg-system substitution depends on the resonance region and cannot be described as a uniform increase or decrease in vibration and acoustic output.

The broader implication is that the peg system warrants consideration not only as a means of tuning, but also as a mechanical component of the coupled body–neck–pegbox structure. Changes to this component were associated with changes in both local structural vibration and the measured acoustic response, supporting its consideration in the acoustic assessment and design of the oud. This conclusion remains specific to the tested instrument and conditions: the measurements do not isolate total peg mass from other mechanical differences or establish tonal superiority under playing conditions.

Further work should combine repeated measurements and installations with controlled added-mass and contact-stiffness series on several ouds. Full-field vibration measurements, modal fitting, and mode-shape comparisons would

help distinguish frequency shifts from changes in modal participation and overlapping responses before assigning standard nodal labels.

Limitations

The comparison concerns one oud without string prestress. Peg-set mass, material, geometry, contact behaviour, and installation variability were not varied independently, so the experiment cannot estimate a separate causal effect for each.

Declarations

Ethics. The study involved instrument measurements only, with no human participants, listening tests, or animal experiments.

Author contribution. The sole author designed the study and conducted the experimental measurements.

Funding. This research received no external funding.

Conflict of interest. The author declares no conflict of interest.

Use of AI. OpenAI ChatGPT assisted with language editing, translation, source checking, and the preparation of deterministic analysis and visualization procedures. No experimental measurements were generated by AI. Scientific responsibility for the data, interpretation, and manuscript remains with the author.

Biodata of Author



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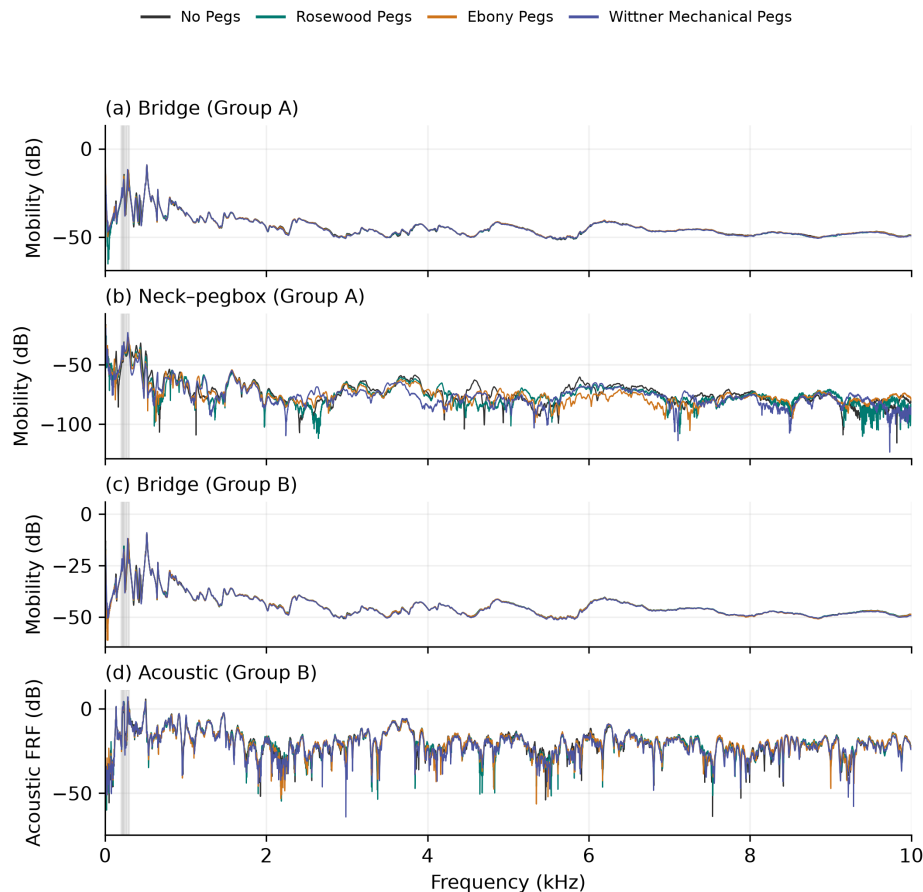
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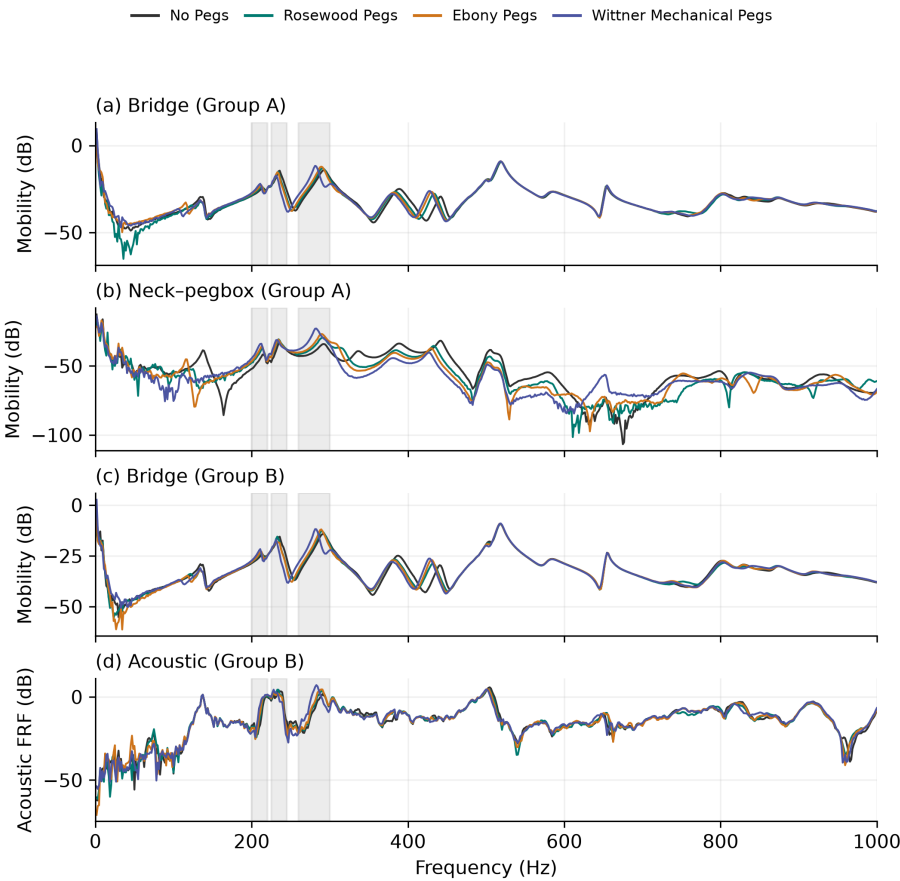
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Supplementary Material

Supplementary Figs. S1 and S2 place the selected resonance regions within the acquired bandwidth and the low-frequency spectral comparison. They use the same four-condition order as the main text: No Pegs, Rosewood Pegs, Ebony Pegs, and Wittner Mechanical Pegs. All curves are derived from the retained complex FRFs without smoothing; no new measurements or statistical sensitivity analysis are introduced. Supplementary Fig. S3 documents the room and setup location.



Supplementary Fig. S1. Full-bandwidth comparison on a 0–10 kHz axis. Panels show (a) Group A bridge mobility, (b) Group A neck–pegbox mobility, (c) Group B bridge mobility, and (d) Group B force-normalized acoustic response. Mobility levels are in dB re 1 m/(N·s), and acoustic levels in dB re 1 Pa/N. The three shaded tracking windows occupy a small part of this bandwidth. All positive-frequency FFT bins are shown (1.5625 Hz spacing); the zero-frequency point is omitted because the mobility conversion is undefined there. The overview documents spectral context, not verified modal identity or uniform measurement quality up to 10 kHz. Group A denotes the paired structural measurements, and Group B the structural–acoustic measurements; bridge mobility is retained separately for each acquisition dataset.



Supplementary Fig. S2. Detailed low-frequency screening view on a 0–1000 Hz axis, with the same panels, units and condition order as Supplementary Fig. S1. The display includes positive-frequency data below the 100 Hz lower limit of main-text Figure 4. Shading identifies Mode 1 (200–220 Hz), Mode 2 (225–245 Hz), and Mode 3 (260–300 Hz). These windows were selected by qualitative comparison; the figure does not rank all resonances by a quantitative sensitivity measure. No mobility value is plotted at zero frequency.

Supplementary Table S1. Coherence at FRF-derived evaluation frequencies for the four measured channel–condition combinations. Group A identifies the structural dataset, and Group B the structural–acoustic dataset; microphone records belong to Group B.

Record / channel / condition	Mode 1 f (Hz); γ^2	Mode 2 f (Hz); γ^2	Mode 3 f (Hz); γ^2
S1 / Neck-pegbox (Group A) / No Pegs	214.06; 0.999844	235.94; 0.999962	292.19; 0.999989
A1 / Microphone (Group B) / No Pegs	214.06; 0.789903	234.38; 0.661683	290.63; 0.719799
A2 / Microphone (Group B) / Rosewood	212.50; 0.666117	232.81; 0.769644	290.63; 0.745463
S2 / Bridge (Group B) / Ebony	212.50; 0.999878	231.25; 0.999683	289.06; 0.999888

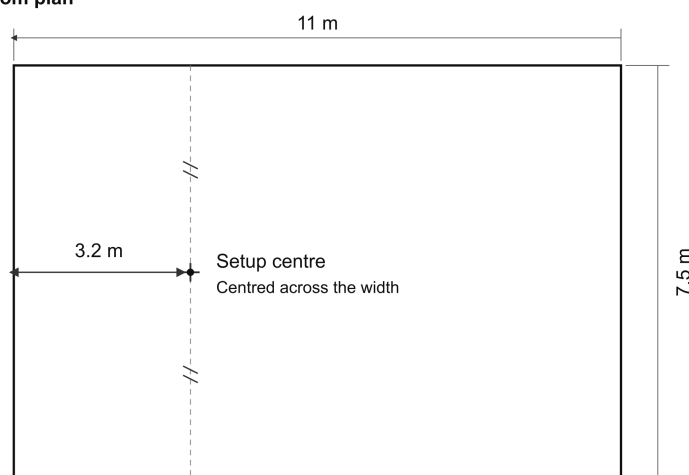
Coherence is dimensionless. Structural values are evaluated at the matched structural FRF maxima. Acoustic Modes 2 and 3 use the acoustic band maxima; acoustic Mode 1 uses the corresponding Group B bridge frequency because no independent acoustic peak was resolved. Frequency-specific values are local quality indicators, not quality estimates for an entire band. Six decimal places retain the exported values and do not express measurement uncertainty.

Across 0–1000 Hz, the median acoustic coherence was 0.684 for No Pegs and 0.700 for Rosewood. Within Mode 2, the window minima were 0.204 and 0.153, whereas coherence at the selected acoustic maxima was 0.662 and 0.770, respectively. No acoustic coherence was acquired for Ebony or Wittner. The full coherence curves, including low values, remain in main-text Figure 7.

(a) Measurement room and fixture



(b) Room plan



Ceiling height: 2.85 m

Centre marker is schematic; apparatus dimensions are not shown.

Supplementary Fig. S3. Measurement environment. (a) Room and fixture without the oud installed; the photograph documents the surroundings, including dark textured wall panels and material beneath the fixture, not an active oud measurement. (b) Plan redrawn from the author's sketch. Equal marks indicate centring across the room width. The centre marker is schematic and does not specify apparatus size or rotation radius.

About

The Journal of Turkish Organology (JTO) (e-ISSN: 3023-7890) is a free, open-access, peer-reviewed scholarly journal that publishes research on musical instruments, including their characteristics, classification, historical development, and etymology. The journal employs a double-blind peer-review process. As the first and only academic journal dedicated specifically to organology, initially with a regional focus and subsequently with an international scope, JTO aims to serve as an important platform for the advancement of this academic discipline. JTO encourages researchers in the field of organology to develop their academic writing skills, use of technological tools, and competencies in musical instrument making, design, modification, and restoration. The journal is published biannually, in March and September. The publication language of the Journal of Turkish Organology is English.

Scope

The scope of the Journal of Turkish Organology (JTO) encompasses academic research in the field of organology as well as interdisciplinary studies related to musical instruments. JTO publishes research articles, review articles, book reviews, and interviews. The journal welcomes studies focusing on the characteristics of musical instruments; their historical development and etymology; musical instrument making and design; modifications, innovations, and improvements in musical instruments; and interdisciplinary research on musical instruments.

