ПРОБЛЕМИ ДОСЛІДЖЕННЯ РЕЧОВИХ ДОКАЗІВ
THE ISSUES OF PHYSICAL EVIDENCE RESEARCH

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FEATURES OF PRICING OF AMBER PRODUCTS IN MODERN CONDITIONS

Abstract. ***The purpose*** of the scientific article is to identify the pricing patterns of raw amber and amber products in modern conditions based on market analysis and interpretation of information in terms of decorative and consumer properties, technological processes of processing. ***Methodology***. The methodological basis of the research is based on general and special methods of scientific cognition. The study uses general scientific and special research methods: analytical, dialectical, comparative legal, systemic and structural, comparative and evaluative, gemological and economic. The main part of the work is based on the practical results of previous research and expert assessments. ***The scientific novelty*** lies in the identification of natural relationships between the weight of products and their cost, between the weight of raw materials intended for the manufacture of a given product and the cost of raw materials. This is used to distinguish the market value, the commercial or marketing value and the forecast value, which reflects real prices, and is used to draw up business plans and expert reports. ***Results***. It is proved that the modern amber market is characterised by the widespread use of Internet resources for the sale of goods, promotion of online sites and shops. It is argued that prices in price lists and on websites of mining, processing and trading companies require systematic analysis in order to understand their formation for amber and amber products. The article reveals natural relationships in pricing of raw amber and amber products in modern conditions based on market analysis (the results are visualized in the form of graphs and illustrated with examples) and interpretation of information, taking into account decorative and consumer properties, technological processes of processing. The author proposes a procedure for determining the market, commercial and forecast value, which consists of the following steps: studying the consumer properties (colour, weight, size, inclusions and cracks, transparency, processing quality, cost); filling the database with information based on the results of the research; using an SQL program to process the results and calculate the cost of raw materials for a sample, the cost of raw materials per gram, and determining the weight of raw materials for the manufacture of a given product. The visualized results of this scientific research are of particular importance in connection with the requirements of the legislation of Ukraine on forensic examination, which defines the principles on which forensic activities are carried out, including the objectivity and completeness of the study.

Keywords: amber; price list; cost; formation algorithm; consumer properties; decorative properties; pricing; expert evaluation.

Introduction

The Ukrainian market, which has survived uncontrolled amber mining (Matsui et al., 2019; Matsui, & Naumenko, 2020; Movchan et al., 2022), is currently in the process of its formation and development. Today, it is being rapidly introduced into the modern European market, as evidenced by the fact that Ukraine has joined public and commercial trade organisations in Europe. First of all, this concerns standards (ISO18323:2015 (E) "Jewellery – Consumer confidence industry") and protection of consumers' rights to receive complete and truthful information about the jewellery and gemstones they buy. At the same time, the global amber market is currently unregulated and subject to significant fluctuations (*Svitovi tsiny na burshtyn padaiut,* 2019, Serpen 13; *Le'amber Consortium*. Raw amber price index, n.d.; *Amber Europe.* 1st Amber Jewelry & Raw Amber Export-Import Market, n.d.).

It should be noted that only two main documents regulate the expert evaluation activity of the amber market in Ukraine.

The first is the National Standard of Ukraine "Raw Amber. General technical conditions" (ДСТУ 8847:2019) (*Tekhnichnyi komitet standartyzatsii «Iuvelirna promyslovist»* (TK 186), 2019, Burshtyn-syrovyna. Zahalni tekhnichni umovy (DSTU 8847:2019); *Derzhavne pidpryiemstvo «Ukrainskyi naukovo-doslidnyi i navchalnyi tsentr problem standartyzatsii, sertyfikatsii ta yakosti»,* 2019, Kiten 17, Pro pryiniattia natsionalnykh standartiv) is of a purely technical nature and defines the rules of supply and acceptance, control methods, methods of transportation, storage and exploitation of raw amber. However, it should be noted that in connection with the reform of Ukrainian legislation in the field of standardisation (*Verkhovna Rada Ukrainy [VRU],* 2019, Veresen 20, Pro vnesennia zmin), the legislator, while regulating legal relations in the field of state regulation of extraction, production use, storage, in particular, of precious stones and control over operations with them, such terms as "world standards", "state standard", "technical conditions" were either replaced by the terms "indicator", "current legislation" or removed altogether. This resulted in a situation whereby the said standard, adopted on 17 April 2019, entered into force on 1 July 2020, and the law on "de-standardisation", adopted on 20 September 2019, entered into force on 16 October 2020. Thus, it can be stated that the current relevant law (*VRU,* 1997, Lystopad 18, Pro derzhavne rehuliuvannia vydobutku) does not mention any standards in this area.

The second is the price list for amber (formed in the bulletin "Price Guide for Precious and Decorative Stones"), which directly relates to the expert assessment of raw amber. It is compiled by the State Gemological Centre of Ukraine (SGCU). However, the disadvantage of price list is a because it is not linked to mining organisations and is not tied to specific Ukrainian deposits. According to a decree of the Government of Ukraine (*Kabinet Ministriv Ukrainy,* 1995, Traven 31, Pro vydannia dovidnykiv optovykh tsin), the SGSU also includes "obligations for the preparation and publication of periodic updates on wholesale prices for diamonds, expensive, non-expensive and decorative stones". In addition, this price list is replete with terminology that has a double meaning or is not specifically explained, which is completely unacceptable in an expert assessment.

At the same time, it is clear that pricing is influenced by other factors, such as the ratio of supply and demand, which ultimately depends on the market strategy of the companies leading in amber extraction and processing (Kelly, 2019).

Forensic examinations and expert studies of amber are the main activity of specialists, experts and appraisers in Ukraine, due to the illegal extraction and sale of amber products in Ukraine (Kovalevskyi, & Kovalevskyi, 2019; Lebid, & Piddubny, 2022). Today, due to the qualitative assessment of amber, it is possible to resolve issues in various fields of activity – from legal, when, for example, property disputes are resolved, to economic of national importance (the growing importance of the assessment and reassessment of amber deposits and ore occurrences, insurance of mining and processing companies, when in-depth information on possible risks for insurance companies is required).

In this regard, the amber market was analysed using data from Internet resources, literature and software.

Purpose and objectives of the study

The purpose of the article is to identify natural relationships in the pricing of raw amber and amber products in modern conditions based on market analysis and interpretation of information, taking into account decorative and consumer properties, technological processes of processing.

In order to achieve this goal, the following tasks need to be performed in this article:

to outline the features of the modern amber market;

to develop a sequence (a set of consecutive steps) for determining the market, commercial and forecast value based on consumer properties; to substantiate the feasibility of creating a relevant database and filling it with information contained on Internet resources, in particular, on commercial websites, as well as on the websites of trade and exhibition sites of domestic and foreign countries, etc.

The sequence of this study is determined by the logic of the tasks set, the structure and content of the

provisions of the current legislation of Ukraine, and the practice of its application.

Summary of the main material

Amber and amber products are widely represented in the global gemstone market. Due to its unique natural qualities, it is an object of jewellery and applied art (Ogden, 2021), it is used as biological supplements, medicines and cosmetic products (Rudko, & Lytvyniuk, 2017).

Forensic gemological examination of amber is especially relevant in modern conditions, as amber is the only gemstone of organogenic origin mined in Ukraine (*VRU,* 1997, Lystopad 18, Pro derzhavne rehuliuvannia vydobutku).

At the same time, amber pricing in modern conditions requires legislative regulation (Kirin et al., 2022). The current price lists compiled by the State Gemological Centre of Ukraine (SGCU) reflect average European prices and depend on the availability of amber on the market (*Ministerstvo finansiv Ukrainy. Derzhavnyi hemolohichnyi tsentr Ukrainy,* 2021, Dovidnyk tsin). Usually the price lists are developed for specific domestic deposits. Therefore, they are more informational (introductory) and are of little use for determining the market value of amber, especially for expert research. After all, the economic characteristics of European countries and Ukraine have different for the mining and geological conditions of deposits and the costs of mining (Martyn, & Kachanovskyi, 2023).

Nevertheless, the decorative properties of amber, which are also consumer properties that shape the pricing policy in the market, are gaining importance in pricing (Dyshlova, 2015). However, they are usually not taken into account when drawing up price lists, which makes it impossible to determine the market, collateral, liquidation, investment or book value. Therefore, this issue needs to be addressed at the legislative and methodological levels.

Internet resources are also used to determine the value of amber and amber products. At the same time, the prices posted on the websites are characterised by specific fluctuations, which constitute a tool for marketers and make it possible to create complex commercial schemes in the amber market, leading to unreasonably high prices for amber. In this situation, it is quite difficult for an expert to find out which prices are real and which are manipulated. Therefore, there is a need to analyse the market for amber products, taking into account its consumer properties.

The amber market currently consists of two main segments – products and raw materials.

The first is a well-publicised segment of products. On the commercial websites of leading companies, high-quality illustrations of the proposed range of products are accompanied by information about the aesthetic properties (colour, purity, inclusions, cracks, inclusions), geometric and economic characteristics (size, weight, cost), and even the so-called medicinal (including magical) properties of amber (Wise, 2021). All this information is intended for buyers (admirers) who are interested in amber and consider amber products as a jewel, taking into account not only their cost but also their quality, origin, naturalness, etc. Another category of people, focusing on the sensory and emotional factor, perceives products as "beautiful – ugly", "cheap – expensive", "like – dislike". Be that as it may, it is the buyer who gives the final assessment of an amber product, i.e. puts an end to this process (*Burmite Amber Grading System,* n.d.). And this is already a strong argument for further market analysis, where both positive and negative aspects of the transaction are considered and taken into account.

The second segment of the amber market is raw materials, which is a relatively modestly advertised area on the Internet. It also involves professionals and amber experts who, based on technological and economic laws, form the information, advertising and pricing policy of amber on the amber market. They are well aware of the fact that the quality and cost of products depend on the quality and cost of raw materials, but they are in no hurry to share their knowledge and experience, as this information is primarily related to business interests.

So, let's look at how these two closely interconnected segments interact in a hierarchical sequence – from the extraction of amber from the subsoil, its processing and sale as a commodity.

It is known that the cost of raw amber consists of the costs of exploration, extraction and taxes. It is very difficult to calculate them, especially after the dramatic changes in the structure of the state's economy (planned regulation was replaced by market regulation). Therefore, this task can be solved by using the situation on the amber market, namely the fact that the cost of amber products is a more or less constant factor. The cost of products, of course, consists of the cost of raw materials and the cost of their manufacture. Thus, the cost of raw materials corresponds to the cost of a product minus the cost of its production.

The link between raw materials and products is the decorative properties of raw amber, and in products, they are consumer properties. Experts representing the International Amber Association (Poland) also note that among natural amber, the most valuable are those in which craftsmen manage to reveal their unique beauty of colour and at the same time preserve the similarity of the natural shape of the samples (Gierlowski, n.d.).

Using the author's methodology, as well as information from commercial websites about the cost of the product, its geometric parameters, and

consumer properties, it is possible to determine the cost of raw materials in the product.

The Amber1 software, developed in C#, Visual Studio, and SQL, can quickly solve this problem (Baranov et al., 2022). This software product is based on the principle of inheritance of amber properties from the product to the raw material, which includes the deduction of the cost of manufacturing products, sales costs, and the yield of usable amber.

Let's take the example of studying amber balls that do not have additional (auxiliary) materials – leather, wood, metal. They are perhaps the most sought-after items among collectors and connoisseurs of natural stones, healers, and magicians.

Balls with a diameter of more than 30 mm are in particular demand, as they require high-quality raw materials in samples of rather large (rare) sizes. Today, unreasonably high prices for such products raise serious doubts among specialists (experts, appraisers) about their objectivity, and this necessitates a thorough investigation of this issue.

The results obtained during the market analysis allowed us to develop a certain sequence for determining the value of raw amber, taking into account consumer properties, which includes the following stages:

study of consumer properties (colour, weight, size, inclusions and cracks, transparency, quality of processing, cost);

filling the database with information based on the research results;

using SQL software to process the results and calculate the cost of raw materials for one sample, the cost of raw materials per gram, and the weight of raw materials.

Ball-shaped products, despite their ideal shape, have a fairly simple manufacturing technology. Therefore, the quality of the raw materials is crucial in the manufacturing process, which is characterised by certain decorative and geometric parameters: isometric shape of the samples, absence of pores and cracks, and ability to accept mirror polishing.

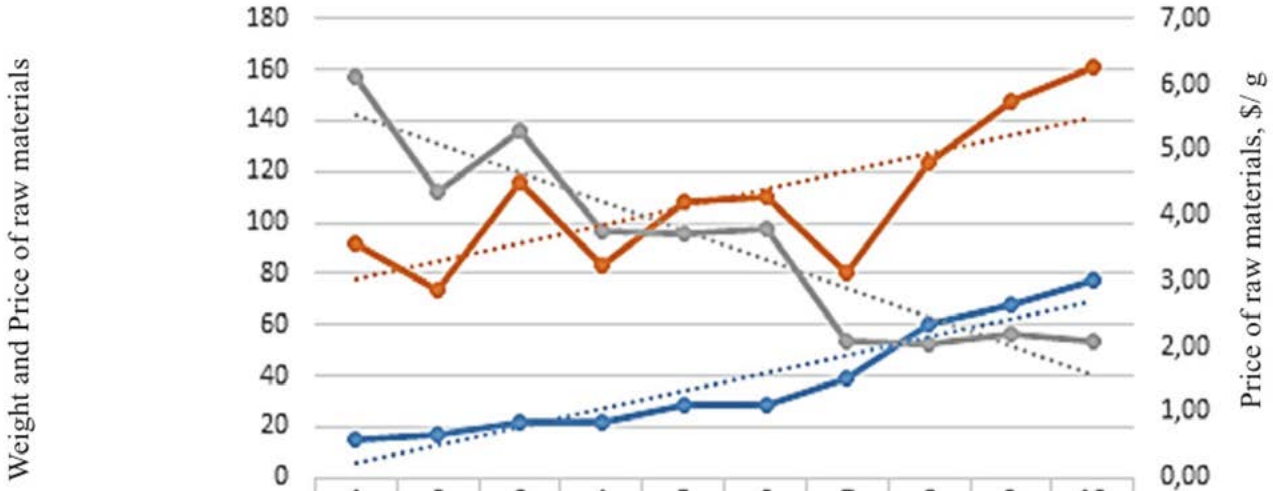
The article analyses the amber balls market based on the data from commercial websites, the results of international exhibitions, and marketing research on prices of specialised boutiques. At the same time, the multifaceted and even contradictory information about amber balls can put an expert or appraiser in a quandary, as there is a certain discrepancy between the cost of the product and the cost of raw amber.

In the course of processing, using a special computer program "Amber1", calculations were made and graphs of the distribution of sample weight, cost per sample ($/piece) and per gram of raw amber ($/g) were drawn.

The results of these studies revealed the following two patterns (Fig. 1):

a direct relationship between the weight fraction and its cost – the higher the weight of the fraction (sample), the higher its cost; Pearson's correlation coefficient between the parameters is 0,842, which corresponds to a fairly strong positive relationship;

the inverse relationship – a negative relationship is observed between the cost of raw materials ($/g) and the weight of raw materials, where the Pearson correlation coefficient between the two parameters is 0,461.



	1	2	3	4	5	6	7	8	9	10
Weight of raw materials,g	15	17	22	22	29	29	39	60	68	77
Price of raw materials, $	91,84	73,96	116,18	82,99	108,13	109,72	80,41	123,13	148,00	160,88
Price of raw materials, $/g	6,12	4,35	5,28	3,77	3,73	3,78	2,06	2,05	2,18	2,09

Fig. 1
Graph of the distribution of economic indicators of raw materials for amber balls

The second pattern contradicts the amber price lists and the general situation on the market.

It is known that the price of raw amber is directly dependent on the size and weight parameters, i.e. the larger the weight of the fraction, the higher its price.

However, the graph of the distribution of economic indicators of raw amber balls (Fig. 1) shows a significant discrepancy between this data and market prices.

Let us illustrate this situation with specific examples.

1. A ball of landscape amber (diameter 19,7 mm, weight 4,5 g, price $306).

To make such a ball, you need an isometrically shaped sample weighing 15g.

From 1 kg of raw landscape amber, with a fraction of 15 g, 66 balls can be made (diameter 19,7 mm, weight 4,5 g).

The cost of the balls is 306×66 = $20,196.

The cost of 1 g of such amber in a 15 g sample will be $6,1.

Then, of course, 1 kg will cost $6100.

2. The ball is also made of landscape amber (diameter 35 mm, weight 23,2 g, price $536).

From the same volume of raw amber, but with a fraction of 77 g, 12 balls can be made (35 mm in diameter, 23,2 g). Their cost would be 536×12 = $6432, and the cost of 1 g of amber (77 g fraction) would be $2.01.

Thus, the cost of 1 kg of raw amber with a fraction of 15 g is $6100, while the cost of amber with a fraction of 77 g is $2001, which is not at all in line with the current market prices for raw amber.

An analysis of the global amber market shows that such raw materials cost slightly more than $1,000/kg.

At the same time, according to the calculations (see Table), the cost of a bullet at $306 should decrease to almost $55, and then the cost of a gram of amber is more plausible.

Table

Adjusted results of the analysis of prices for amber balls

Colour	Weight of the fraction, g	Fractional value, $/piece	Price of raw materials, $/ g	Market value of products, $	Calculated product cost, $
Honey white	15	16,5	1,1	306	55
Honey white	17,3	21	1,2	247	70
Honey white	21,6	27,9	1,3	387	93
Honey white	21,6	28,2	1,3	277	94
Honey	29	40,5	1,4	360	135
Honey white	29,3	48	1,6	366	160
Honey	39,3	68,4	1,7	268	228
Honey	59,9	123,13	2,1	410	410
Honey	77,3	183	2,4	536	710

In the adjusted graph (Fig. 2), the curves for the cost of raw materials per gram and the weight of raw materials for the production of balls with the appropriate size are in direct correlation, which reflects the current situation and no longer contradicts market prices for raw materials.

The proposed sequence of determining the value of raw amber, taking into account consumer properties, involves working with both individual samples and large batches of amber. For this purpose, it is necessary to create a database containing information on the cost of products, their weight, size and consumer properties, as well as the cost of raw amber.

The situation is similar for bracelets and necklaces with beads in the form of spheres with a diameter of 6 to 22 mm. The complexity of the calculations for this type of product was that the cost of one bead was calculated first, and then the entire product. The volume of drilled amber (weight) in the beads was compensated by the weight of the product's thread. The study of bracelets and necklaces, followed by data processing to confirm the above research, revealed similar patterns.

Thus, the results of this scientific research are of particular relevance in the context of the requirements of the legislation of Ukraine on forensic examination, which defines the principles on which forensic activities are carried out (*VRU,* 1994, Liutyi 25, Pro sudovu ekspertyzu, st. 3), including the objectivity and completeness of the study.

Scientific novelty

The article reveals the natural relationships between the weight of products and their cost, between the weight of raw materials intended for the manufacture of a particular product and the cost of

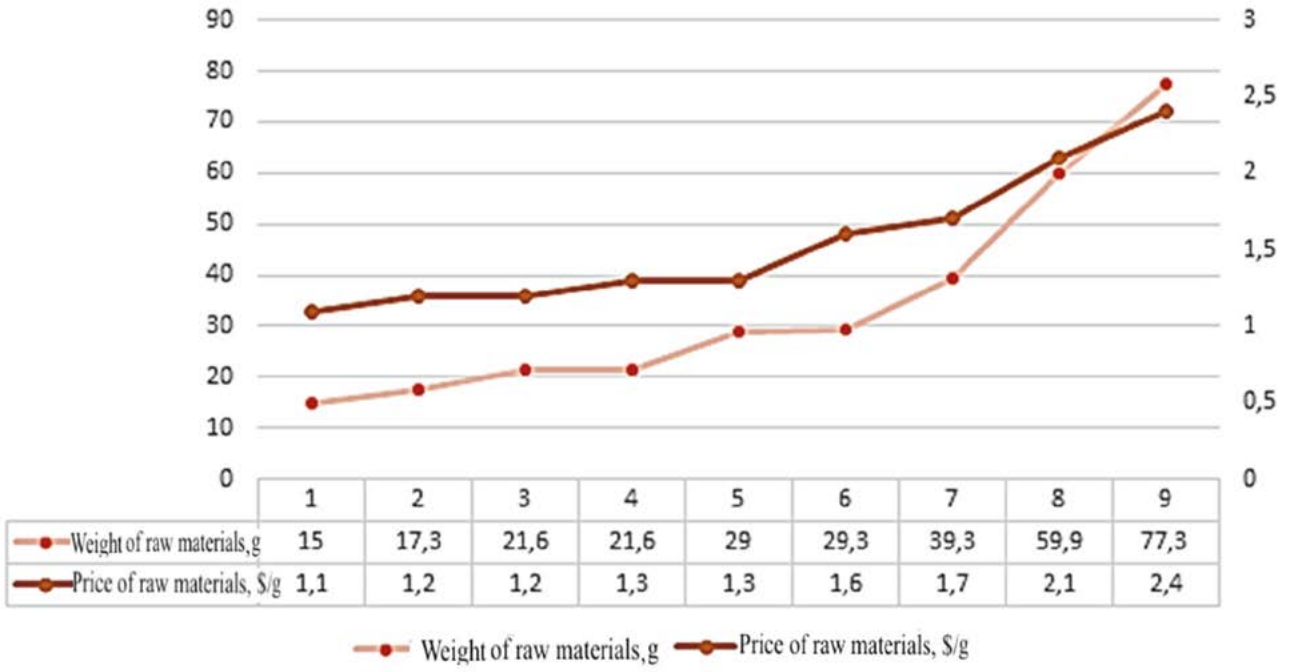


Fig. 2
Adjusted graph of the distribution of curves and trend lines

raw materials. They make it possible to distinguish the market value, which satisfies the buyer, the commercial or marketing value, which is a tool for "warming up the market", and the forecast value, which reflects the actual prices and is used for drawing up business plans and expert assessments.

Conclusions

The author underlines that the peculiarities of the modern amber market are the widespread use of Internet resources for selling goods, promoting online websites and shops. It is stated that prices in price lists and on the websites of mining, processing and trading enterprises require systematic analysis to understand their formation for amber and amber products. It is noted that prices may: be aimed at satisfying the buyer (market prices); serve as a tool for "warming up the market" (commercial or marketing prices); reflect the real prices used for drawing up business plans and expert assessments (forecast prices).

Based on the regularities identified in the course of the research (the results are presented in the form of graphs and illustrated with examples), the author proposes a sequence for determining the market, commercial and forecast value, which consists of the following stages:

studying consumer properties (colour, weight, size, inclusions and cracks, transparency, processing quality, cost);

filling the database with information based on the research results;

using SQL software to process the results and calculate the cost of raw materials for one sample, the cost of raw materials per gram, and the weight of raw materials for the manufacture of a particular product.

The results of the research influence the further pricing of products, where the decorative properties of amber play an important role, which are also consumer properties that shape the pricing policy in the market.

The practical significance of the results obtained is that they can be used in forensic examinations and expert studies, as well as in research and educational activities, applied in the economic, financial and economic activities of the subjects of the relations under consideration, in law-making and law enforcement activities of public authorities to improve national legislation.

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Conflict of interest

None.

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