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DOI <https://doi.org/10.15673/gpmf.v21i3.2228>**L. Valevskaya, PhD of Technical Science, Associate Professor, E-mail: ludmila_valev@ukr.net**<https://orcid.org/0000-0003-0511-5643>, ResearcherID: F-8756-2016**O. Sokolovskaya, PhD of Technical Science, Senior Lecturer, E-mail: sokolovskaya_alena@meta.ua**<https://orcid.org/0000-0003-4326-1932>, ResearcherID: N-5304-2015**A. Iegorova, PhD of Technical Science, Associate Professor, E-mail: antoninaegorova59@gmail.com**<https://orcid.org/0000-0002-3122-7692>, ResearcherID: B-2642-2016*Odessa National Academy of Food Technologies, 112, Kanatna Str., Odessa, 65039, Ukraine*

DETERMINATION OF QUINO SEED SAMPLES

Abstract

Quinoa is a promising crop due to its use in the food industry for the development of functional products. But there are very few recommendations in the world literature and almost no practical experience in the storage and processing of quinoa seeds. The study of quinoa and its properties in Western countries, as well as the development of modern methods of organic production in South America have led to the fact that quinoa is rapidly gaining popularity as a healthy and healthy product rich in vitamins and minerals and gluten-free. This has caused a boom in production and exports in Latin America, which continues to this day.

In Ukraine, quinoa has gained popularity in recent years, many Ukrainian cereal producers now include quinoa in their range. But so far, raw materials have been purchased abroad, primarily in Latin America.

Grain quality is a set of properties and characteristics (organoleptic, biological, physicochemical, technological, consumer) that determine the suitability of grain for its intended use. The main indicators of quinoa grain quality of different types: white, red and black are determined in the work. The quality of the studied samples was determined by organoleptic, chemical and microbiological indicators.

The results of the sensory analysis confirm the high results and the display of the grain of the quinoa by species.

The acidity of the grain of quinoa is determined, and it is set according to the indicators of acidity, until the acidity of the grain of quinoa is brought to good grain.

The results of microbiological studies show that the highest content of bacteria was found in samples of red quinoa seeds. The analysis of the obtained results showed that the predominant component of the bacterial microflora of quinoa grain is the non-spore-forming bacillus *Erwinia herbicola*. Molds of the genus *Aspergillus* and *Mucor* were found in samples of white quinoa seeds, fungi of the genus *Penicillium* in samples of red quinoa seeds, and no molds were found in samples of red quinoa seeds. Microbiological study showed that all samples were free of both pathogenic and opportunistic pathogens.

Organoleptic, chemical and microbiological indicators confirm the satisfactory quality of the studied quinoa grain samples.

Key words: quinoa, grain quality, organoleptic indicators, microbiological indicators, acidity.

Introduction

Quinoa is a fashionable product, one of the most popular superfoods in the world. Back in the 1990s, NASA scientists identified it as the ideal cereal for astronauts because it fully meets the nutrient needs of the human body. In light of the current trend, as long as you can stay young and healthy, interest in quinoa has grown again.

Quinoa (quinoa, quince) - a cereal crop belonging to the pseudograin, an annual plant of the Amaranth family.

At present, quinoa seeds are no longer an exotic product for Ukrainians, they can be found on the shelves of all major supermarkets, as well as tried in leading restaurants. Quinoa is widely represented in the recipes of vegetarian, gluten-free diets, weight control diets, as a low-calorie protein product, the amino acid composition of which is close to milk [1-4].

Despite the fact that the yield of quinoa is three times higher than the yield of buckwheat (5-6 t/ha against 1.5-3 t/ha), the cost of quinoa is significantly higher. The reason for the high cost is that the plant is much more demanding of growing conditions and does not tolerate low temperatures. In fact, the high price is due to the peculiarity of cultivation and distance of transportation [5, 6].

Interest in the culture of quinoa as a non-traditional raw ingredient for the consumer when creating

multi-component recipes is justified by its high nutritional value and chemical composition. In terms of chemical composition, quinoa seeds contain all the necessary macronutrients: proteins - 14... 20 %, fats - 6.1 % and carbohydrates - 57.2 %.

A distinctive feature of quinoa culture is the content of high quality protein. In terms of protein content, quinoa seeds have the highest values, which exceed the data on corn protein by 4.6 times, rice - 2.1; wheat - 1.8; millet and oats - 1.6 times. The high protein content of quinoa grains allows it to compete with well-known high-protein plant products such as barley, buckwheat and amaranth. Moreover, some varieties of quinoa seeds contain more than 20 % protein [3, 5].

An additional positive aspect of the evaluation of the protein component of quinoa seeds is the fact that, unlike wheat and rice, which contain a small amount of lysine, the amino acid composition of quinoa grain proteins is quite balanced and close to milk protein, which reaches 20 types of amino acids.

Calculation of the biological value of the protein component of quinoa grains revealed the presence of 2 limiting essential amino acids. However, this does not reduce the value of quinoa culture as a promising source of protein in the composition of multicomponent food recipes [1, 3-5].

In Ukraine, quinoa has gained popularity in recent years, many Ukrainian cereal producers now include



quinoa in their range. But so far, raw materials have been purchased abroad, primarily in Latin America. However, since 2019, work has been underway on sowing quinoa seeds in Ukraine [2, 6, 7].

There are three main varieties of quinoa seeds - red, yellow and black. Each species differs in both color and taste. Also a popular variation of "tricolor" - or tricolor mixture.

Note that all three types of quinoa seeds have identical characteristics - that is, we can not say that one of them is better or more useful than the other. However, the color of quinoa seeds is due to the presence (or absence) of a protective shell - and a number of substances that are part of it.

The bitter taste of some quinoa species is due to the presence of saponins in the shell of the grain - natural pesticides that protect crops from birds and insects. Most often, before going on sale, the shell is removed mechanically - that is, the grain is cleaned. That is why the yellowish-white quinoa seeds have a milder taste and are traditionally used for cooking and baking. In turn, red and black quinoa seeds have a denser structure and are better suited for adding to salads.

Grain quality is a set of properties and characteristics (organoleptic, biological, physicochemical, technological, consumer) that determine the suitability of grain for its intended use. The quality of grain supplied to enterprises affects the conditions and time of storage. Even a slight excess of this figure leads to the inevitable deterioration of the grain mass.

Normally ripe, healthy grain has characteristics (shape, size, condition of integumentary tissues, gloss, color, which characterize the appearance), as well as smell and taste (determined in addition). Various adverse factors that occur during the cultivation of grain, active biological processes that occur during improper storage, can lead to loss of freshness and quality of grain. Grains with significant deviations in color (discolored or darkened) are classified as defective in grain or waste impurities.

Fresh grain should not have foreign odors, their appearance indicates a deviation from the norm as a re-

sult of adverse effects. Foreign odors in grain are divided into two groups: sorption origin (absorbed) and decomposition odors (as a result of undesirable biological processes).

The aim of the work is to determine the quality of quinoa seeds of different species.

Object of research: quinoa seed quality indicators.

Subject of research: three types of quinoa seeds: red, black and white.

Research methodology

Determination of quinoa grain quality was performed on the following main indicators: organoleptic indicators, acidity and microbiological indicators.

Organoleptic assessment of grain quality is of great practical importance, as it gives a preliminary idea of the benefits of grain mass, and is of paramount importance to the consumer, as quickly, without any physico-chemical studies gives a general idea of product quality. It is these indicators that have the psychological effect on the consumer, as a result of which he leaves his choice on this product [8]. Organoleptic indicators of grain quality include color, odor, taste. Organoleptic evaluation of quinoa seeds was determined in accordance with GOST 10967-90 and the developed score scale taking into account the weighting factors (Table 1).

The scoring system allows for organoleptic evaluation of quinoa seed samples with their assignment to one of the following categories: "excellent" (with a total score of 4.5-5.0 points), "good" (4.0-4.5 points), satisfactory "(3.5-4.0 points) and "unsatisfactory "(below 3.5 points).

According to DSTU ISO 6658: 2005 - "Sensory research. Methodology. General guidelines "sensory analysis was performed using methods of analytical evaluation by descriptive method (profiling method) and the method of using scales and categories (scoring) [8].

To study such important components of consumer properties of the product as "taste", "smell" and "color" used the method of profiling, the essence of which is that the complex concept of one of the organo-

Table 1 - Scale for assessing the quality of quinoa seed samples

Quality indicators	Weighting factor	Characteristics of the indicator, points				
		5	4	3	2	1
1	2	3	4	5	6	7
Color	0,2	Pleasant, matching the color of the seeds by type	Quite nice, matching the color of the seeds in appearance	Not pleasant enough, the color of the products slightly does not match the color of the seeds in appearance	Unpleasant, different shades	Not typical of this type of seed
Taste	0,5	Pleasant, suitable for this type of seed, pronounced, without extraneous flavors	Pleasant, suitable for this type of seed, pronounced, without extraneous flavors	Weakly expressed	Not expressed taste	Not appropriate, outsider flavor
Smell	0,3	Pleasant, appropriate, pronounced, odorless	Pleasant, appropriate, pronounced, odorless	Weak odor	Unscented odor	Unsuitable odor

leptic properties is represented as a set of simple components evaluated by tasters, intensity and order of manifestation [9]. This method is the most informative because it covers all aspects of sensory quality of food and allows you to identify which components of taste, smell, color and texture are most relevant to the consumer properties of the product.

Acidity was determined according to GOST 26971-86. The method is based on potentiometric titration with sodium hydroxide solution of the total amount of free fatty acids, organic acids, end groups of proteins contained in grain and products of its processing and able to pass into the aqueous extract.

Microbiological studies of samples were performed for three samples of quinoa seeds of different species using both modern methods of determination (microbiological analyzer BakTrak 4300), whose work is based on recording changes in electrical resistance of the nutrient medium due to microorganisms, and classical methods. Samples were taken in sterile containers under aseptic conditions, which exclude contamination of the product with microbes from the environment. The composition of the microbiota of quinoa grain was determined by microbiological and sanitary indicators, which include the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFANM), micromycetes (molds and yeasts), bacteria of the Escherichia coli group (followed by Escherichia coli). Staphylococcus aureus.

The total number of bacteria was determined by sowing washes of varying degrees of dilution in meat-pepton agar (MPA), molds and yeast - in wort agar (CA) followed by cultivation at a temperature of $(30 \pm 1)^\circ\text{C}$ for 24-48 hours and $(28 \pm 1)^\circ\text{C}$ for 5-7 days, respectively. Spore forms of bacteria were determined in pasteurized washes from samples that were sown on a complex nutrient medium MPA and CA in a ratio of (1:1).

The presence of bacteria of the Escherichia coli group was established by sowing the grain wash in Kessler medium by the method of fermentation samples and evaluated by gas formation and turbidity of the medium.

The presence of potentially pathogenic staphylococci was established by accumulating them in meat-pepton broth with NaCl 6% and reseeded on milk salt agar. Cultivated in both crops for 24 hours at a temperature of $(37 \pm 1)^\circ\text{C}$.

Quinoa grain was also analyzed for the presence of mycotoxins (aflatoxins B1, zearalenone, deoxynivalenol) using the Veratox test system.

Research results

Panels of taste, color and smell descriptors were presented for tasting, and the tasters gave their scores on a conditional five-point scale. The research results are shown in Fig. 1-3.

The following descriptors were taken into account during the study of taste by profiling:

- positive - general impression, harmonious, grain;
- negative - fresh, bitter, unpleasant aftertaste.

As can be seen from the profilogram, all types of quinoa seeds were characterized by harmonious taste, pleasant and grainy taste.

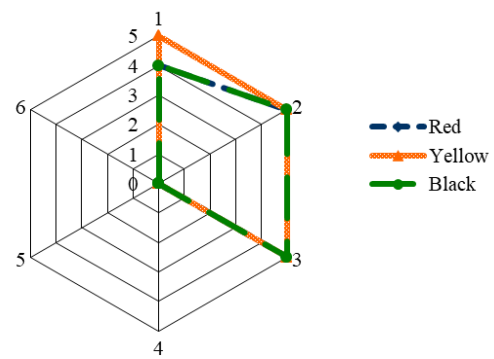


Fig. 1. Profilogram of taste of quinoa seed samples: 1 - general impression; 2 - harmonious; 3 - grain; 4 - fresh; 5 - rancid; 6 - unpleasant aftertaste

To evaluate the samples of quinoa seeds by color and odor, profilograms were constructed, which are shown in Fig. 2-3.

As can be seen from the profilograms presented in Fig. 2-3, quinoa seed samples, regardless of color and odor, have an attractive, pleasant color and a pronounced grain odor

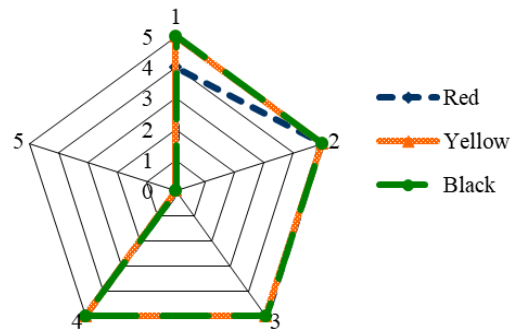


Fig. 2. Profilogram of color samples of quinoa seeds: 1 - attractive; 2 - pleasant; 3 - corresponding to the type of seed; 4 - uneven; 5 - does not correspond to the type of seed

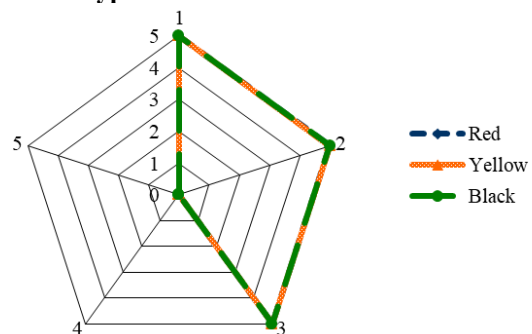


Fig. 3. Prophylogram of the smell of quinoa seed samples: 1 - pronounced, 2 - grain; 3 - pleasant; 4 - mild; 5 - third party

The tasting commission also evaluated the quinoa seed samples according to the developed score (Table 1), the results of which are shown in Table 2.

Thus, the results of sensory analysis confirm the high results of samples of quinoa seeds by species. Samples of quinoa seeds, regardless of color, are characterized by a harmonious taste, a pleasant slightly grainy taste and have a pleasant color. According to the results of the tasting evaluation, the samples received the highest

**Table 2 - Evaluation of organoleptic quality indicators of quinoa seed samples, scores**P \geq 0,95, n=3

Type of quinoa seeds	Name of indicators without weighting factor / with weighting factor			Overall quality assessment	Quality category
	Color	Taste	Smell		
Red	5,0/1,0	5,0/2,5	5,0/1,5	5,0	perfectly
Yellow	5,0/1,0	5,0/2,5	5,0/1,5	5,0	perfectly
Black	5,0/1,0	4,9/2,45	5,0/1,5	4,95	perfectly

number of points, which corresponds to the quality category "excellent".

Grain acidity is an important indicator of their quality. During storage and grain acidity, as a rule, increases. Thus, it can serve as an indicator of quality, more precisely, an indicator of the freshness of grain or products of its processing.

Grain acidity depends, first, on proteins that are known to contain carboxyl groups that bind alkali. Secondly, the acidity of the grain also depends on the fatty acids that are released as a result of the breakdown of fats by lipase. Third, the acidity of grain and flour depends on phosphoric acid, which in the form of various compounds contained in the grain in significant quantities. Fourth, the acidity of the grain also depends on acetic, lactic, malic and other organic acids (including the Krebs cycle), which are usually contained in grains and flour in small quantities. The content of acetic and lactic acids increases significantly if the grain, cereals or flour spoiled as a result of self-heating or acidification [10]. As a result of the experiments, the following acidity values were obtained for different types of quinoa grain: white - 1.8 deg., Red - 2.4 deg., Black - 2.1 deg. All tested samples of quinoa grain belong to good quality grain.

Seeds are a living organism, and therefore it is a set of chemical transformations - metabolism, which ensures their viability. Metabolic processes in a living organism have a dual direction - anabolic (synthesis) and catabolic (splitting of synthesized substances). During anabolism there are processes of energy absorption by mainly reductive chemical processes, during catabolism - oxidative chemical reactions and energy is released [11-14].

The composition and more developed microbiota of grain and products of its processing are significantly affected by different storage regimes [11, 12]. Infection of products with microorganisms is on average - tens of thousands of bacteria per 1 g [12]. The products are dominated by bacteria *Erwinia herbicola*, the number of which reaches 70-90% of the total number of bacteria, spore-forming and cocci contains 5-15%. The content of fungal spores ranges from one percent to 1-5% of the total number of microorganisms. The fungal flora of the seeds is represented mainly by species of *Penicillium* [14]. During long-term storage in conditions where the humidity of the product and temperature exclude the possibility of microbiota development, there is a gradual decrease in the total number of bacteria as a result of the death of non-spore-forming forms [15].

Therefore, the study of the qualitative and quantitative composition of the microflora is important for the development and practical application of various processing methods to improve the stability and extend the

shelf life of quinoa grain for further use in food, feed, pharmaceutical, microbiological and feed industries.

The indicator of the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFANM) is the most common microbiological indicator. It is used in the food industry as an indicator of the sanitary condition of production.

We determined the qualitative composition of the microflora is an indicator of safety, as the presence of pathogenic microorganisms or increased content of opportunistic pathogens compared to the permissible norm can be the cause of poisoning.

The results of microbiological study of quinoa grain are given in table. 3

Table 3 - Results of microbiological examination of quinoa seed samples

Type of quinoa seeds	Bacteria, CFU/g	Molds, CFU/g
White	1,1 · 10 ²	90
Red	5,2 · 10 ²	Not found
Black	1,0 · 10 ²	600

The results of microbiological studies show that the highest content of bacteria was found in samples of red quinoa. The analysis of the obtained results showed that the predominant component of the bacterial microflora of millet grain is the non-spore-forming bacillus *Erwinia herbicola* - a representative of the epiphytic microflora. It is believed that the number of these bacteria is an indicator of grain freshness. The percentage of *Erwinia herbicola* bacteria from the total number of all bacteria is 75%, which confirms the good quality of grain. The share of coliform bacteria in millet grain was 15.6%.

Molds of the genus *Aspergillus* and *Mucor* were found in white quinoa samples, fungi of the genus *Penicillium* in samples of red quinoa, and no molds were found in red quinoa samples.

Microbiological study showed that all samples were free of both pathogenic and opportunistic pathogens.

Conclusions

In Ukraine, quinoa has gained popularity in recent years, many Ukrainian cereal producers now include quinoa in their range. But so far, raw materials have been purchased abroad, primarily in Latin America.

We have identified the main indicators of quinoa grain quality, which determine the suitability of grain for its intended use. According to organoleptic parameters, regardless of color, quinoa grain samples are characterized by a harmonious taste, a pleasant slightly grainy



taste and have a pleasant color.

Red quinoa has the highest acidity - 2.4 degrees, but all studied samples of quinoa grain are of good quality grain.

As a result of the experiments, the following acidity values were obtained for different types of quinoa grain: white - 1.8 deg., Red - 2.4 deg., Black - 2.1 deg. All tested samples of quinoa grain belong to good quality grain, as the acidity value is not 3 degrees.

The results of microbiological studies show that the highest content of bacteria was found in samples of red quinoa. The analysis of the obtained results showed

that the predominant component of the bacterial microflora of millet grain is the non-spore-forming bacillus *Erwinia herbicola* - a representative of the epiphytic microflora.

Among the micromycetes previously, mold fungi of the genus *Aspergillus* and field fungi of the genus *Mucor* were detected in white quinoa samples, and mold fungi of the genus *Penicillium* in red quinoa samples, and molds were not detected in red quinoa samples.

Thus, organoleptic, chemical and microbiological indicators confirm the satisfactory quality of the studied samples of quinoa grain.

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Л.О. Валецька, канд. техн. наук, доцент, E-mail: ludmila.valev@ukr.net

О.Г. Соколовська, канд. техн. наук, старший викл., E-mail: sokolovskaya_alena@meta.ua

А.Єгорова, канд. техн. наук, доцент, E-mail: antoninaegorova59@gmail.com

Одеська національна академія харчових технологій, вул. Канатна, 112, Одеса, 65039, Україна

ВИЗНАЧЕННЯ ПОКАЗНИКІВ ЯКОСТІ ЗРАЗКІВ НАСІННЯ КІНОА

Анотація

Кіноа є перспективною культурою з огляду використання у харчовій промисловості для розробки продуктів функціонального призначення. Але у світовій літературі досить мало рекомендацій та майже відсутній практичний досвід щодо зберігання та обробки кіноа. Вивчення кіноа і його властивостей в західних країнах, а також розвиток сучасних методів органічного виробництва в Південній Америці привели до того, що кіноа стрімко завойовує популярність в якості здорового і корисного продукту, багатого вітамінами і мінералами і не містить глютен. Це викликало бум виробництва і експорту в латиноамериканських країнах, який триває до теперішнього часу.



В Україні кіноа придбала популярність в останні роки, багато українських виробників круп зараз включають кіноа в свій асортимент. Але до теперішнього часу закупували сировину за кордоном, в першу чергу в країнах Латинської Америки.

Якість зерна – це сукупність властивостей та ознак (біологічних, фізико-хімічних, технологічних, споживних), які визначають придатність зерна до вживання за призначенням. В роботі визначено основні показники якості зерна кіноа різних видів: білі, червоне, чорне. Визначення якості досліджуваних зразків проводилося за органолептичними, хімічними та мікробіологічними показниками.

Результати сенсорного аналізу підтверджують високі результати зразків насіння зерен кіноа за видами.

Визначено кислотність зерна кіноа, та встановлено що за показниками кислотності усі досліджувані зразки зерна кіноа відносяться до доброякісного зерна.

За результатами мікробіологічних досліджень видно, що найбільший вміст бактерій виявлено у зразках червоного кіноа. Аналіз отриманих результатів показав, що переважною складовою бактеріальної мікрофлори зерна просо є неспорують паличка *Erwinia herbicola*. У зразках білого кіноа було виявлено плісеневі гриби роду *Aspergillus* та *Mucor*, у зразках чорго кіноа – гриби роду *Penicillium*, при цьому у зразках червоного кіноа плісеневі гриби не виявлено. Мікробіологічне дослідження показало, що в усіх зразках відсутні як патогенні, так і умовно патогенні мікроорганізми.

Органолептичні, хімічні та мікробіологічні показники підтверджують задовільну якість досліджених зразків зерна кіноа.

Ключові слова: кіноа, якість зерна, органолептичні показники, мікробіологічні показники, кислотність.

ЛІТЕРАТУРА

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