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Development of methods for assessing the quality of snail meat

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Abstract. The meat of edible snails is considered a delicacy and is part of Ukraine's food exports, but there are no regulations or legislation on its quality. The purpose of this work was to develop methods for determining the degree of freshness of snail meat by the content of ammonia and ammonium salts with Nessler's reagent, peroxidase in meat with copper sulfate solution, and processing a smear-print from meat with a fluorescent dye and to determine the quality of meat by the number of green pixels. During the research, first of all, it was determined the organoleptic characteristics of shellfish meat, which reflect their freshness. Next, research was performed to determine the enzymes and ammonia that are produced during meat storage. The following reagents were used: copper sulfate solution, Nessler's reagent, and fluorescent dye – acridine orange. The equipment used for these reactions was used, namely: a KFK-2-UHL 4.2 photometer and an SMT fluorescence microscope with a working current of 2.5 A. Thus, schemes for establishing reactions for determining the degree of freshness of snail meat were developed and tested: biochemical, photometric, and immunofluorescence methods. The stability of the indicators for determining the degree of freshness was established. It is analysed that the data presented relate only to the research on snail meat. Utility model patents have been granted for each method. The proposed methods for assessing the quality of snail meat are effective, technologically simple and fast, have high reliability of the results obtained and can be used in the work of research and experimental, production and regional laboratories of veterinary medicine

Keywords: gastropod, determination of freshness, biochemical method, photometric method, immunofluorescence reaction

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INTRODUCTION

The quality of animal products is of great importance in Ukraine and globally. For the vast majority of Ukrainians, snails are an unusual delicacy, both due to the specifics of their consumption and their rather high price. The snail business in Ukraine is at the initial stage of development, thus, there is not enough scientific research on the consumer properties and safety of snails as a biologically valuable food product.

Babina *et al.* (2017), Down (2018) argue that meat quality control is one of the top priorities, as the quality of the products received by the consumer and their cost depends on the objectivity of freshness assessment. In addition, snail meat should be subjected to a freshness test (Kasianchuk & Bohatko, 2006). After analysing the publications of other foreign scientists Kehinde *et al.* (2020), та Kougiagka *et al.* (2022), it was established that there are no methods for determining the quality of snail meat. For rapid quality control of meat of different species of animals and poultry, there are conventional methods for determining the freshness of meat: pH, peroxidase reaction (benzidine test), copper sulfate reaction, hydrogen sulfide reaction, ammonia reaction, formalin reaction, ammonia and ammonium salts determination (Danilova & Hetmanets, 2018; Kasianchuk & Bohatko, 2003). These are standard methods for determining the freshness of animal meat. Notably, they are not designed and cannot be used specifically for snail meat.

Similar studies highlighted in the scientific publication by Ukrainian scientists Yatsenko *et al.* 2020 are significant but only concern the determination of the degree of freshness of snail meat by the content of ammonia and ammonium salts with the Nessler reagent but since the reaction is visual, it can be subject to error. In addition, there is a method for determining the degree of freshness of snail meat by reacting with copper sulfate, for which the authors later received a similar patent. The authors of this patent use a different concentration of meat and water extract for research and take snail meat at different periods after anabiosis (Zabarna & Bohatko, 2019).

It is difficult to give an unambiguous definition of the quality of fresh meat, as each consumer will describe it differently based on their preferences, which will vary depending on the perception of the product's appearance, odour, and flavour (Purslow, 2017; Karabasil *et al.*, 2019). In this case, it is necessary to use more precise research methods. The quality of fresh meat determines its usefulness for the consumer and its suitability for cooking (Przybylski & Hopkins, 2016). Since Ukrainian farmers export snails and their meat, it is essential to determine the degree of freshness on time.

Meat quality assessment is a kind of art, in which technological and methodological skills, instrumentation and laboratory equipment, professional experience and aptitude for tasting play an important role (Raudienė *et al.*, 2018). According to the freshness indicators, meat is divided into fresh, questionable freshness and stale. The quality can be assessed by organoleptic methods (appearance, flavour, odour, colour, consistency, and in some cases juiciness), sensory highly instrumental methods (colour, odour), histological (microstructural) methods (Peshuk, 2018; Umer *et al.*, 2021). Determination of organoleptic indicators does not give a complete picture of the quality and safety of meat, it is necessary to conduct additional laboratory tests, such as physicochemical, microbiological etc (Bohatko *et al.*, 2015; Liu *et al.*, 2018).

The issue of meat quality was explored by Kasianchuk & Bohatko (2006), who developed a way to improve the biochemical method for determining beef from diseased animals. In addition, these authors developed a method for determining the degree of freshness of beef and pork and received a utility model patent for it (Kasianchuk & Bohatko, 2003). There is a method for determining the degree of freshness of poultry meat using the photometric method, authored by Bohatko *et al.* (2015). But all these methods are not suitable for determining the quality of snail meat.

Shellfish meat is a product that is not resistant to long-term storage. According to Ng *et al.* (2013), it is explained by: the loose structure of muscle tissue, low amount of glycogen in the muscles, high water content, which serves as a favourable environment for the development of microorganisms, and the ability of snail microflora to develop at low positive temperatures (0... + 5°C). But its quality depends on storage conditions (Batyrbekov & Zhumabaev, 2017). Most snail meat is frozen. Therewith, unfavourable conditions are established for the development of microorganisms, and the rate of biochemical processes under the influence of enzymes is sharply reduced (Damez & Clerjon, 2008; Soren & Biswas, 2020). However, note that the meat can be frozen for a very long time, compliance with the requirements for freezing shellfish meat or during transportation, and there are no temperature requirements (Saryglar, 2020).

The purpose of this work is to identify the quality of snail meat by developing methods for determining the degree of freshness.

MATERIALS AND METHODS

The work was performed during 2018-2019 at the Department of Chemistry and Biochemistry of the Kharkiv State Zooveterinary Academy. Three methods for determining the quality of snail meat were developed: a method for determining the degree of freshness of snail meat by the biochemical method; a method for determining the degree of freshness of snail meat by the photometric method; and a method for determining

the degree of freshness of edible snail meat by immunofluorescence. Utility model patents have been obtained for each of the methods: No. 134319 (Danilova, 2019), No. 128984 (Danilova & Hetmanets, 2018), and No. 136331 (Danilova & Hetmanets, 2019), respectively. These methods are individual both in their design and in the results obtained. Therefore, performers, or the laboratory in general, have the opportunity to choose the most convenient and affordable option for themselves. In a series of experiments, meat from 150 snails of the *Helix pomatia* species was used.

Research on determining the degree of freshness of snail meat by the biochemical method. More than 60 snails were selected and the meat was extracted (8 to 17 g per snail). The meat samples were divided into 2 groups of 30 samples each. In terms of shelf life, these groups corresponded to two categories: 1) fresh meat; 2) stale meat. Next, meat samples of different concentrations were prepared, with dilutions of 1:10, 1:15, 1:20, 1:25, and 1:30. In conical flasks, 20.0, 25.0, 30.0, 35.0, and 40.0 g of chopped snail meat were separately placed and 200.0, 300.0, 400.0, 500.0, and 600.0 cm^3 of distilled water were added, respectively. The contents of the flasks were stirred, closed with a watch glass, and placed in a boiling water bath for 10 minutes. The contents of the flasks were then filtered through a layer of cotton wool. If the resulting broth was cloudy and protein flakes remained in it after filtering, the broth was filtered through filter paper. The filtrate from each flask was poured into test tubes of 2.0 cm^3 each. A copper sulfate solution of different concentrations was prepared in parallel: 1.0%, 1.5%, 2.0%, 2.5%, and 3.0%. For this, 1.0, 1.5, 2.0, 2.5, and 3.0 g of copper sulfate were weighed, and 100.0 cm^3 of distilled water was added to each sample. Subsequently, 3 drops of copper solution at 1.0%, 1.5%, 2.0%, 2.5%, and 3.0% concentrations were added to the tubes of each dilution of the filtrate. Distilled water was used as a control. For this purpose, to 2.0 cm^3 of water, 3 drops of CuSO4 of different concentrations were added. The tubes were shaken 3 times and placed on a rack. The reaction was recorded visually after 5 minutes by changing the colour and consistency of the broth (Danilova, 2019).

Method for determining the degree of freshness of snail meat by the photometric method. It was selected 45 snails of the species *Helix pomatia*, from which meat was removed (from 8 to 11 g each). The meat samples were divided into 3 groups of 15 samples each. In terms of shelf life, these groups corresponded to three categories: 1) fresh meat; 2) stale; 3) questionable. Next, the meat samples were chopped with scissors and 2.0 g of each was taken (15 samples for each group). To 5 weights of each group were added 10.0, 20.0, 30.0, 40.0, and 50.0 cm^3 of distilled water, respectively (3 series of 5 weights in total) and infused for 15 minutes, filtered, and 0.5 cm^3 of Nessler's reagent was added to 3.0 cm^3 of filtrate. Then, the optical density of the colour intensity of the supernatant for each sample was immediately measured using a KFK-2-UHL 4.2 photoelectric photometer in a cuvette with an absorbing light thickness of 1.0 cm at wavelengths of 400, 440, 490, and 540 nm. Distilled water was used as a control (Danilova & Hetmanets, 2018).

Development of a method for determining the degree of freshness of edible snail meat by immunofluorescence. More than 45 snails were selected and the meat was extracted (8 to 11 g per snail). The meat samples were divided into 3 groups of 15 samples each. In terms of shelf life, these groups corresponded to three categories: 1) fresh meat; 2) stale meat; 3) meat of questionable freshness. From the surface of the cut of each meat sample, smears were placed on a slide. The smears were dried at room temperature. Then they were fixed in chilled chemically pure acetone for 30 minutes at -18°C by complete immersion. Next, the smears were removed, air-dried at room temperature, and transferred to a humid chamber, where they were stained with a working solution of acridine orange dye (dilution 1:10,000) in a dark place for 20 minutes at room temperature. The dye is a catalyst for the immunofluorescence reaction. Subsequently, the smears were washed with distilled water 3 times. They were air-dried and examined in an SMT fluorescence microscope with a working current of 2.5 A (40×10 magnification) (Danilova & Hetmanets, 2019). The image of each sample was displayed on a computer monitor and further analysed using "Adobe Photoshop 7.0" software. For this, the image size was set to a constant 1777×1333=2368741 pixels (according to the dimensions of the monitor screen). The "Histogram" command was used to check the presence and corresponding total size of green spots X (in pixels) in the image (Baranovsky *et al.*, 2017).

All experimental studies were conducted according to modern methodological approaches and in compliance with the relevant requirements and standards, in particular, they correspond to the requirements of DSTU ISO/IEC 17025:2005 (2006). The animals were kept and all manipulations were performed according to the provisions of the Procedure for conducting experiments and experiments on animals by scientific institutions (Law of Ukraine No. 249, 2012), the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (European convention…, 1986).

RESULTS AND DISCUSSION

Method for determining the degree of freshness of snail meat by biochemical method. The results of this method are presented in Tables 1 and 2.

***Table 1**. Reaction of copper with sulfate of fresh snail meat*

Diluting broth	CuSO4 concentration, %				
	1.0	1.5	2.0	2.5	3.0
1:10	The broth is clear, brown in colour		The broth is blue-brown in colour, with brown flakes		
1:15	Transparent brown liquid		Transparent blue-brown liquid		
1:20	Transparent brown liquid		Transparent blue-brown liquid		
1:25	Transparent brown liquid		Transparent blue-brown liquid		
1:30	Transparent brown liquid		Transparent blue-brown liquid		
Distilled water	Transparent liquid with a subtle blue tint on a contrasting background				

***Source:** developed by authors*

***Table 2**. Reaction of copper with sulfate of stale snail meat*

Diluting broth	CuSO4 concentration, %				
	1.0	1.5	2.0	2.5	3.0
1:10	The broth is clear, brown in colour		The broth is blue-brown in colour, with brown flakes		The broth is blue-brown in colour, significantly cloudy, with brown flakes
1:15	Transparent brown liquid	Transparent blue-brown liquid	Blue-brown broth, barely noticeable brown flakes, traces of jelly generation	Blue-brown broth, barely noticeable brown flakes, traces of jelly generation	
1:20	Transparent brown liquid	Transparent blue-brown liquid	Transparent liquid of blue-brown colour, with brown flakes, traces of jelly generation	Transparent liquid of blue-brown colour,with brown flakes with jelly generation	
1:25	Transparent liquid of blue-brown colour, with barely noticeable brown flakes				Transparent liquid of blue-brown colour, with barely noticeable brown flakes, traces of jelly generation
1:30	Transparent liquid of blue-brown colour, with barely noticeable brown flakes				Transparent liquid of blue-brown colour, with barely noticeable brown flakes, traces of jelly generation
Distilled water	Transparent liquid with a subtle blue tint on a contrasting background				

***Source:** developed by authors*

Thus, analysing the data for determining the freshness of snail meat in the reaction of copper with sulfate, which is presented in Tables 1 and 2, it can be concluded that the authors' data are consistent with the study of a 1:15 meat-water extract and CuSO4 concentrations of 2.5% or 3.0%. Thus, to determine the degree of freshness of snail meat in the reaction of copper with sulfate, it is necessary to use a meat-water extract at a dilution of 1:15 and a CuSO4 concentration of 2.5% or 3.0%.

Research results in the development of a method for determining the degree of freshness of snail meat by the photometric method. The results obtained during the development of this method are presented in Table 3 in the form M ± m, where M – the average optical density for the group, m – the error of the average.

For clarity, the average values are presented in Figure 1.

***Table 3**. Colour intensity optical density values of the supernatant by groups*

Groups	Wave length, nm			
	400	440	490	540
1	2	3	4	5
Fresh meat				
1. (1:10 + 0.5 cm^3 Nessler's reagent)	1.28 ± 0.11	0.26 ± 0.03	0.30 ± 0.03	0.42 ± 0.05
2. (1:15 + 0.5 cm^3 Nessler's reagent)	0.65 ± 0.06	0.46 ± 0.03	0.42 ± 0.04	0.12 ± 0.02

Table 3, Continued

1	2	3	4	5
3. (1:20 + 0.5 cm³ Nessler's reagent)	0.52 ± 0.07	0.53 ± 0.06	0.54 ± 0.08	0.10 ± 0.02
4. (1:25 + 0.5 cm³ Nessler's reagent)	0.52 ± 0.06	0.27 ± 0.03	0.15 ± 0.02	0.06 ± 0.01
5. (1:30 + 0.5 cm³ Nessler's reagent)	0.45 ± 0.06	0.25 ± 0.03	0.12 ± 0.02	0.05 ± 0.01
Stale meat				
1. (1:10 + 0.5 cm³ Nessler's reagent)	1.38 ± 0.06	1.24 ± 0.03	1.80 ± 0.05	1.46 ± 0.07
2. (1:15 + 0.5 cm³ Nessler's reagent)	1.80 ± 0.07	1.37 ± 0.06	1.91 ± 0.05	1.40 ± 0.06
3. (1:20 + 0.5 cm³ Nessler's reagent)	1.10 ± 0.03	1.46 ± 0.02	2.10 ± 0.04	0.95 ± 0.05
4. (1:25 + 0.5 cm³ Nessler's reagent)	0.68 ± 0.07	0.36 ± 0.03	0.29 ± 0.03	0.10 ± 0.02
5. (1:30 + 0.5 cm³ Nessler's reagent)	0.95 ± 0.08	0.56 ± 0.06	0.26 ± 0.03	0.55 ± 0.05
Questionable meat				
1. (1:10 + 0.5 cm³ Nessler's reagent)	0.69 ± 0.08	0.80 ± 0.05	0.85 ± 0.05	0.84 ± 0.10
2. (1:15 + 0.5 cm³ Nessler's reagent)	0.93 ± 0.07	0.83 ± 0.04	1.58 ± 0.04	0.97 ± 0.07
3. (1:20 + 0.5 cm³ Nessler's reagent)	1.18 ± 0.08	1.17 ± 0.03	1.63 ± 0.05	1.35 ± 0.09
4. (1:25 + 0.5 cm³ Nessler's reagent)	1.00 ± 0.07	0.99 ± 0.07	0.86 ± 0.06	0.69 ± 0.06
5. (1:30 + 0.5 cm³ Nessler's reagent)	0.71 ± 0.07	0.78 ± 0.08	0.59 ± 0.06	0.93 ± 0.09

Source: *developed by authors*

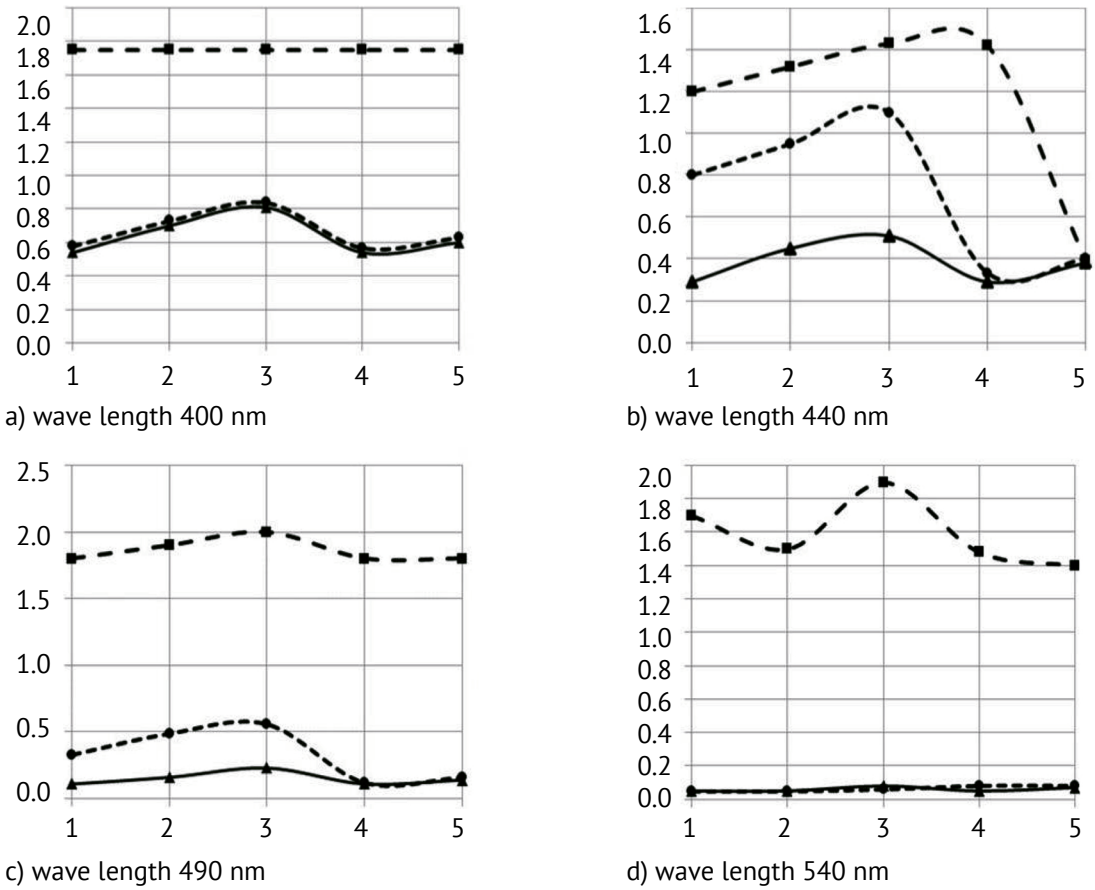

Figure 1*. Dependence of the average values of the optical density of the colour intensity of the additive fluid on the group number*

Note: *1 – 1 : 10 + 0.5 cm³ of Nessler's reagent; 2 – 1 : 15 + 0.5 cm³ of Nessler's reagent; 3 – 1 : 20 + 0.5 cm³ of Nessler's reagent; 4 – 1 : 25 + 0.5 cm³ of Nessler's reagent; 5 – 1 : 30 + 0.5 cm³ of Nessler's reagent. Fresh meat – ▲, questionable meat – ●, stale meat – ■*

Source: *developed by authors*

The data in Table 3 and Figure 1 demonstrate that the highest reliability of the difference between fresh, stale and questionable snail meat is obtained by photometry at 440 and 490 nm and using a meat-water extract in ratios of 1 : 10, 1 : 15 or 1 : 20 with the addition of 0.5 cm^3 of Nessler's reagent. Low extract concentrations of 1 : 25 and 1 : 30 are generally uninformative in determining the degree of freshness of meat.

These conclusions can be summarised in Table 4, which presents the ranges of changes in the optical density of colour intensity according to the degree of freshness of snail meat at 440 and 490 nm. The ranges were determined according to the "three sigmas" rule according to Table 3, i.e., about 99.9% of the experimental data fell into these ranges.

As can be seen from this Table, the ranges of optical density for different degrees of the freshness of meat do not overlap, thus, Table 4 can be specifically applied to the examination of snail meat to its degree of freshness.

***Table 4**. Indicators of optical density of colour intensity according to the degree of freshness of snail meat*

Wave length, nm	The degree of freshness of meat		
	Fresh	Questionable freshness	Stale
	Dilution of meat and water extract 1 : 10		
440	0.10-0.42	0.54-1.06	1.08-1.40
490	0.12-0.48	0.53-1.07	1.44-1.98
	Dilution of meat and water extract 1 : 15		
440	0.33-0.59	0.61-1.05	1.07-1.67
490	0.21-0.63	1.37-1.79	1.84-2.36
	Dilution of meat and water extract 1 : 20		
440	0.24-0.82	0.95-1.31	1.35-1.57
490	0.15-0.93	1.41-1.85	1.91-2.29

***Source:** developed by authors*

Obtained data on the method of determining the degree of freshness of edible snail meat by immunofluorescence. Conducted research to determine the degree of freshness of edible snail meat by immunofluorescence. The results are presented in Table 5.

***Table 5**. Results of measuring the immunofluorescence of snail meat*

No. of sample	Number of pixels, X	The ratio of the number of pixels X to the total number, %	Average value of M, pixels (percent)	Standard deviation σ, pixels (percent)
1	2	3	4	5
		Fresh meat		
1	0	0.000	285.7 (0.012%)	211.5 (0.009%)
2	82	0.003		
3	90	0.004		
4	102	0.004		
5	150	0.006		
6	161	0.007		
7	211	0.009		
8	252	0.011		
9	253	0.011		
10	303	0.013		
11	386	0.016		
12	435	0.018		
13	507	0.021		
14	645	0.027		
15	708	0.030		

Table 5, Continued

1	2	3	4	5
Meat of questionable freshness				
16	1091	0.040		165.6 (0.008%)
17	1133	0.048		
18	1178	0.050		
19	1221	0.052		
20	1301	0.055		
21	1378	0.058		
22	1402	0.059		
23	1414	0.060	1386.9 (0.058%)	
24	1457	0.062		
25	1492	0.063		
26	1502	0.063		
27	1511	0.064		
28	1545	0.065		
29	1567	0.066		
30	1611	0.068		
Stale meat				
31	4235	0.179		1272.2 (0.054%)
32	4649	0.196		
33	4917	0.208		
34	5132	0.217		
35	5572	0.235		
36	5821	0.246		
37	6008	0.254		
38	6140	0.259	6270.8 (0.265%)	
39	6307	0.266		
40	6614	0.279		
41	7031	0.297		
42	7391	0.312		
43	7756	0.327		
44	8124	0.343		
45	8365	0.353		

Source: *developed by authors*

In this Table, samples 1 through 15 deliberately corresponded to fresh meat; samples 16 through 30 to the meat of questionable freshness; and samples 31 through 45 to stale meat. Since the total number of pixels in each image was a large value of 2368741, Table 5 presents the absolute number of pixels for each sample, since the corresponding percentages to the total number are extremely small. Table 5 presents the mean values and standard deviations of the number of pixels for each group of snails by the degree of freshness. The Figure 2 presents probability density plots of the normal distribution for each group of snails in Table 5 according to formula (1):

$$f(X) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(X-M)^2}{2\sigma^2}} \quad (1)$$

which are compared with the results of observations (points on the graphs).

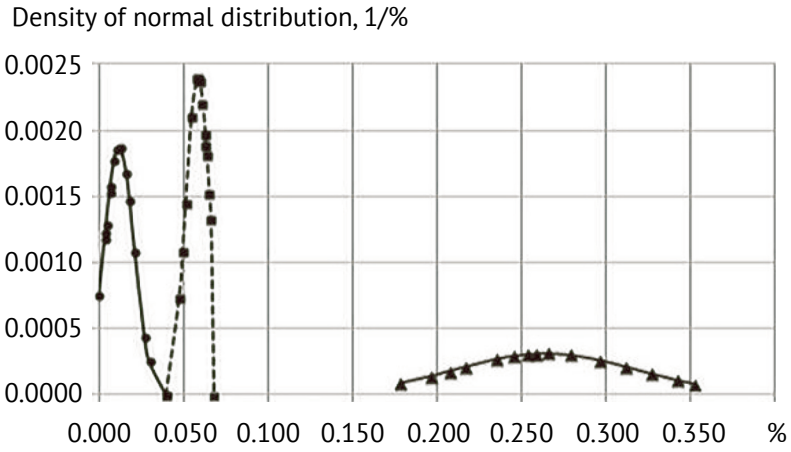

***Figure 2**. Graphs of the normal distribution of the percentage of green pixels from the total number of pixels in the image for each group of snails*

***Note:** Fresh meat – , questionable meat – , stale meat –*

Figure 2 demonstrates that the boundary between fresh meat and meat of questionable freshness is at the level of 1000 pixels (0.042%) of green colour, and if the number of pixels exceeds 2000 (0.084%), the meat is stale.

The authors have developed three methods for determining the quality of snail meat, which are simple and expressive, but believe that the photometric method is more acceptable. This method requires using inexpensive equipment that is available in almost all laboratories, while the researcher will get a reliable, fast result, and the Nessler reagent gives a clear colour intensity.

Ukrainian scientists have been exploring the degree of freshness of snail meat and have developed methods to the determination of the degree of freshness of snail meat by bacterioscopic method (Zabarna & Bohatko, 2019), photometric method (Zabarna & Bohatko, 2019), reaction with copper sulfate (Zabarna & Bohatko, 2019), and ammonia and ammonium salts (Zabarna & Bohatko, 2019). The similarity of these methods with the methods developed by the authors is that the studies were conducted on snails and used Nessler's reagent and copper sulfate solution. Differences include various concentrations of meat and water extracts and reagents and different reaction times. To ensure the accuracy of the results, the author offers to use special equipment, which will ultimately provide a smaller error.

In addition, these methods can be used to determine the degree of freshness, but each researcher should choose the simplest, accurate, and acceptable method for them. The authors Kasianchuk & Bohatko (2006) та Bohatko *et al*. (2015) determined the quality of meat but from other species. Researchers Onishchenko *et al*. (2006) have developed a method for the rapid diagnosis of blood-borne diseases of sheep using fluorescence microscopy, but it cannot be used to explore snail meat, as it involves fluorochromation of preparations, as a result of which the parasites themselves become a source of light and contrast against the dark background of the preparation, and in this case, fluorochromation in preparations occurs due to meat spoilage. Thus, the less bright green colour in the microscope, the fresher the meat.

Similar studies are covered in scientific publications by foreign researchers – Sando *et al*. (2012), Kehinde *et al*. (2020), but they do not devote sufficient attention to the analysis of indicators responsible for the quality and safety of gastropod meat. Thus, considering the growth of snail consumption and exports in Ukraine, the issue of snail meat quality examination is very relevant, interesting and significant.

CONCLUSIONS

Snail meat can be analysed by biochemical, photometric and immunofluorescence methods. The modes of performing each method have been developed. Thus, when using the biochemical method, it is necessary to obtain a meat and water extract at a dilution of 1 : 15 with a CuSO4 concentration of 2.5% or 3.0%. When testing with this method, the extract from fresh meat is transparent blue-brown in colour, and from stale meat, the broth turns blue-green in colour with jelly generation. Determination of the degree of freshness of meat with the Nessler's reagent is possible by examining the meat-water extract in dilutions of 1 : 10, 1 : 15 and 1 : 20 on the KFK-2-UFL 4.2 at a wavelength of 440 nm or 490 nm. Thus, the author found that with a dilution of the meat-water extract of 1:15 and a wavelength of 440 nm, the degree of freshness can be determined. If the indicator is from 0.33 to 0.59 nm, the meat is considered fresh, with indicators of 0.61 to 1.05 nm – of questionable freshness, and from 1.07 to 1.67 nm – stale. It was established that it is possible to determine the quality of snail meat by immunofluorescence. If the indicator is 1000 pixels, the meat is considered fresh, and if it is more than 2000 pixels, it is stale. As a prospect for further research, it is considered advisable to determine what factors affect the freshness of snail meat.

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Розробка методів оцінки якості м'яса равликів

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Анотація. М'ясо їстівних равликів вважається делікатесом і становить частину українського експорту харчових продуктів, але нормативні та законодавчі документи щодо його якості відсутні. Метою цієї роботи було розробити способи визначення ступеня свіжості м'яса равликів за вмістом аміаку та солей амонію з реактивом Неслера, пероксидази в м'ясі з розчином міді сульфату та обробки мазка-відбитка з м'яса флуоресцентним барвником і за кількістю пікселів зеленого кольору встановити якість м'яса. В ході досліджень, у першу чергу, визначали органолептичні показники м'яса молюсків, які відображають їх свіжість. Далі виконували дослідження щодо визначення ферментів та аміаку, які утворюються у процесі зберігання м'яса. При цьому були використані наступні реактиви: розчин міді сульфату, реактив Неслера та флуоресцентний барвник – акридиновий помаранчевий. При постановці даних реакцій також було використано і обладнання, а саме: фотометр фотоелектричний КФК-2-УХЛ 4,2 та люмінесцентний мікроскоп SMT з подачею робочого струму 2,5 А. Таким чином були розроблені та відпрацьовані схеми постановки реакцій щодо визначення ступеня свіжості м'яса равликів: біохімічний, фотометричний та метод імунофлюоресценції. Була визначена стабільність показників визначення ступеня свіжості. Проаналізовано, що наведені дані стосуються лише дослідження м'яса равликів. На кожен метод було отримано патенти на корисну модель. Запропоновані способи оцінки якості м'яса равликів є ефективними, технологічно нескладними та швидкими, мають високу достовірність отриманих результатів і можуть бути використані в роботі науково-експериментальних, виробничих та регіональних лабораторіях ветеринарної медицини

Ключові слова: брюхоногий молюск, визначення свіжості, біохімічний метод, фотометричний метод, реакція імунофлюоресценції