MICROBIOLOGICAL INDICATOR OF CROCKETS FLOUR

Sereda O.,
Graduate Student, of Department of Food Technology
Sumy National Agrarian University
Ukraine, Sumy,
Melnyk O.
PhD in Technical Sciences,
Associate Professor of the Department of Food Technology
Sumy National Agrarian University
Ukraine, Sumy
DOI: 10.5281/zenodo.10700511

Abstract

Cricket flour is gaining popularity in the Ukrainian market because it has a high crude protein content (up to 70.0%). This type of raw material is offered to a large category of people: athletes, people who monitor their nutrition, children and adults. However, for its widespread use in food products, in accordance with the legislation of Ukraine, it is necessary to conduct a number of studies.

One of such studies is the determination of microbiological indicators. The paper investigated and compared microbiological parameters of cricket flour compared to wheat flour. Based on the results of research, it was determined that flour from crickets meets the requirements of the legislation of Ukraine in terms of microbiological indicators, so it can be used in the production technology of whipped flour semi-finished products.

Keywords: flour from crickets, wheat flour, microbiological indicators, semi-finished whipped flour, food safety.

Introduction

In Ukraine, the demand for healthy food with the use of new types of raw materials, new methods of technological processing, and the use of resource-saving and eco-technologies is growing every year. That is why food manufacturers are expanding their range of products by using different types of raw materials, including raw materials supplied abroad. Such raw materials, as a rule, contain components that enrich products with macro- and micronutrients, vitamins, proteins, and have a wide range of functional properties.

However, according to the Law of Ukraine "On the Quality and Safety of Food Products", raw materials of foreign production must undergo a number of studies to establish their compliance with Ukrainian standards and wide use [18].

The safety of raw materials sold within Ukraine is assessed by qualitative and quantitative indicators, organoleptic, physicochemical, toxicological, and in particular microbiological properties.

Research of microbiological indicators is carried out for all food products sold within Ukraine, and new products that are in great demand among consumers require a particularly careful study of their properties. One of these products is whipped flour semi-finished products (SFP) using cricket flour.

It is known that SFP make up more than 10% of the entire flour confectionery market. They have good taste and aromatic properties, but low content of proteins and vitamins [19].

The content of proteins, vitamins, dietary fibers, and minerals in the SFP is defined as the sum of the corresponding components of the recipe components included in the SFP. One of these components is wheat flour (WH). It is known that during the production of wheat flour, the outer shell of the grain is removed, which contains a large group of dietary fibers, vitamins and minerals [21].

Therefore, the inclusion of innovative raw materials, both Ukrainian and foreign production, in the formulation of the SFP is expedient and scientifically substantiated [9, 10, 12, 15, 20].

Analysis of recent research and publications. In recent years, many researchers have considered insects as a potential source of alternative proteins. From the analysis of the world practice of using insect flour, it is known that insects can be consumed in three variations: as whole insects, ground into powder, and as an extract (protein isolate) [13].

In Europe, America, Africa, Asia, China, etc., products of cricket processing - flour or cricket powder - are used for consumption.

Cricket flour (CF) is made from crickets of the genus Acheta domesticus using various processing methods (freezing, frying, drying) to ensure microbiological purity and safety, increase shelf life and improve the sensory appeal of raw materials [16, 17]. The use of such processing methods is of crucial importance for increasing the shelf life of raw materials and slowing down the deterioration processes of CF [4].

Scientists [1] note in their work that for further production of flour from whole fresh crickets, the insects must be starved for 24 hours, then washed with water and subjected to blanching at a temperature of 100^0C for 1 minute then freeze at –18 °C. Frozen crickets are lyophilized within 24 hours. Dried samples are ground into powder using a mill. Before storing under vacuum in the refrigerator, the resulting flour is sifted through sieves with a hole diameter of 1.25 mm.

Other researchers [14] used frozen insects for the manufacture of flour from crickets and its subsequent use in the recipe of various types of cereals. Before making flour, crickets were thawed at a temperature of 50 ^{0}C for 12 hours. After thawing, the samples were washed at a temperature of 18^0C to remove dirt and heat treated in hot water at 100 °C for 5 minutes for effective

sterilization. Crickets were dried in an oven at 60^0C for 24 hours. After drying, the insects were crushed using a laboratory grinder and sifted through a sieve with a hole diameter of 0.595 mm. The produced powder was packed in sterile polyethylene bags with a fastener and stored at a temperature of 4^0C for its further use.

In their works, researchers [21] used the method of washing insects with sodium hypochlorite solution and subsequent freezing at a temperature of -24^0C; blanching was carried out at a temperature of 100^0C for 5 minutes. After that, the method of drying using an electric cabinet at 80^0C for 7 hours was used.

Conducted research on CF production has shown that methods of processing fresh or frozen crickets can lead to the destruction of the main nutrients contained in insects.

Also, according to research data [7], it was found that the quality of flour may deteriorate during long-term storage of BC. The main problem that leads to a decrease in the shelf life of flour is microbiological contamination, as a result of which the color of the flour can change and it can become bitter.

In this study, flour from crickets, which is sold within Ukraine but produced in Great Britain, was used for the production of semi-finished batter. Taking into account research data [5, 8] that crickets can be infected with pests and spoilage microorganisms that contribute to the deterioration of the properties of raw materials during long-term storage and sale. Therefore, before using raw materials from insects in food technology, it is important to determine the microbiological indicators of its quality.

The aim of this study. The aim of this study is to determine the microbiological indicators of the quality of flour from crickets for its further use in the technology of food processing.

Results and discussion For the production of SFP, the following were used: chicken eggs - TM Yasen Svit (DSTU 5028:2008), sugar TM Komora Krup (DSTU 4623:2006), wheat flour TM Khutorok (TU U 15.6- 2778401454-001:2006) , citric acid TM "UNA" (DSTU GOST 908:2006), flour from crickets TM "SENS Foods" London UK [2].

Cricket flour belongs to the products that are imported abroad with the corresponding accompanying documentation (Document 32022R0188) [2], and is classified as a product that requires thorough research to determine microbiological indicators before use. Therefore, before introducing CF into the formulation of the SFP, studies of the microbiological parameters of the raw materials were conducted, since in view of the production of CF, it may contain microorganisms, the content of which does not allow the use of the studied raw materials in the production of food products. These studies were conducted at the Sumy Regional Center for Disease Control and Prevention of the Ministry of Health.

Among the microbiological indicators, the total number of aerobic colonies of microorganisms, the number of mold fungi, yeast, Escherichia coli, pathogenic microorganisms, including salmonella, Listeriamonocytogenes, bacteria of the Enterobacteriacae family, sulfite-reducing anaerobes, Bacilluscereus, coagulase-positive staphylococci.

Simple nutrient agar was chosen as a nutrient medium for determining the total number of aerobic colonies; quantities of mold fungi, yeast - Saburo agar; pathogenic microorganisms, including salmonella - selenite broth; Listeriamonocytogenes, bacteria of the Enterobacteriacae family, sulfite-reducing anaerobes - Kesler's medium; Listeriamonocytogenes, bacteria of the Enterobacteriacae family, sulfite-reducing anaerobes, Bacilluscereus, coagulase-positive staphylococci - Ploskirev's medium, Edel's and Kompelmacher's medium, respectively.

Table 1

Results of microbiological studies of wheat flour

Name of the indicator	Units of measurement	Requirements of regulatory documents	The results of tests
1	2	3	4
MAFAN/total number of aerobic colonies	CFU/g	no more $1,0*10^5$	$5,7*10^1$
Mould fungi	CFU/g	no more $1,0*10^2$	$1,0*10^1$
Yeast	CFU/g	no more $1,0*10^2$	no more 10
Escherichia coli	CFU/g	no more $5,0*10^1$	not found
Pathogenic microorganisms, including salmonella	in 25 g	not permitted	not found
Listeriamonocytogenes	in 25 g	not permitted	not found
Bacteria of the genus Enterobacteriacae	CFU/g	no more $1,0*10^2$	not found
Sulphite-reducing anaerobes	CFU/g	no more $3,0*10^1$	not found
Bacilluscereus	CFU/g	no more $1,0*10^2$	less than 10
Coagilasepos. Staphylococcus	CFU/g	no more $1,0*10^2$	not found

Table 2

Results of microbiological studies of cricket flour

Name of the indicator	Units of measurement	Requirements of regulatory documents	The results of tests
1	2	3	4
MAFAN/total number of aerobic colonies	CFU/g	no more $1,0*10^5$	$7,0*10^1$
Mould fungi	CFU/g	no more $1,0*10^2$	$2,0*10^1$
Yeast	CFU/g	no more $1,0*10^2$	no more 10
Escherichia coli	CFU/g	no more $5,0*10^1$	not found
Pathogenic microorganisms, including salmonella	in 25 g	not permitted	not found
Listeriamonocytogenes	in 25 g	not permitted	not found
Bacteria of the genus Enterobacteriacae	CFU/g	no more $1,0*10^2$	not found
Sulphite-reducing anaerobes	CFU/g	no more $3,0*10^1$	not found
Bacilluscereus	CFU/g	no more $1,0*10^2$	less than 10
Coagilasepos. Staphylococcus	CFU/g	no more $1,0*10^2$	not found

Taking into account the results of the studies presented in Table 2 and comparing them with the results of studies of microbiological parameters of wheat flour (Table 1), the CF contains a total number of aerobic colonies of 7.0*101 CFU/g, which is higher than in wheat flour, but is an acceptable norm for flour; the number of plastid fungi is 2.0*101 CFU/g, in turn, in wheat flour up to 1.0*101 CFU/g; yeast is not more than 10 CFU/g, pathogenic microorganisms, including Salmonella. Salmonella were not detected, as well as a number of microorganisms harmful to the human body.

Based on the data obtained, the microbiological characteristics of CF comply with the state standards of Ukraine, which are regulated for wheat flour [6], i.e., cricket flour is almost indistinguishable from wheat flour in terms of microbiological characteristics, so it can be used as an innovative ingredient in the production of whipped flour semi-finished products.

After researching an innovative ingredient in a semi-finished whipped flour product, it is important to determine the microbiological characteristics of the finished product.

The main indicators for determining the microbiological safety of whipped flour semi-finished products were the presence of mesophilic aerobic and facultative anaerobic microorganisms (CMAFAnM), Escherichia coli bacteria, S. Aureus, pathogenic microorganisms, in particular bacteria of the Salmonella genus, yeast and mould fungi.

The study of the dynamics of changes in microbiological safety indicators of the SPF was determined during the storage of the semi-finished product in four variations: 1 - immediately after cooling (12 hours), 2 - after 48 hours of storage (2 days), 3 - after 96 hours of storage (4 days), 4 - after 168 hours of storage (7 days). The storage of the SPF was carried out at an ambient temperature of 18-20 °C hermetically packed in cling film. The recommended shelf life of the whipped flour semi-finished product is 7 days.

Table 3

Results of microbiological studies of spongecakewith 10.0% cricket flour

Name of the indicator	Shelf life of the product			
	12 h.	48 h.	96 h..	168 h.
KMAFAnM CFU in 1 g, not more than	$1,0*10^4$	$1,0*10^4$	$1,0*10^4$	$1,0*10^3$
The weight of the product, g, which is not allowed:				
BCCP (coliforms) S	Not found			
S. aureus	Not found			
Pathogenic microorganisms, including Salmonella	Not found			
Yeast, CFU per 1 g, not more than	10,0	10,0	10,0	10,0
Mould fungi, CFU per 1 g, not more than	$1,0*10^2$	$1,0*10^2$	$1,0*10^2$	$1,0*10^2$

According to DSTU 4803:2007 [3], the shelf life of foamy semi-finished products is 7 days. According to microbiological indicators, the permissible rate of CFU per 1 g is not more than $5*10^3$, in this work $1.0*10^{3-4}$; product weight, g, is not allowed: BCCP (coliforms) S - 0.1, S. Aureus - 1.0, pathogenic microorganisms, in particular Salmonella - 50. In the study of CFU, no pathogenic microorganisms were detected during the shelf life; Yeast, CFU per 1 g, not more than 50, according to Table 3 yeast, CFU per 1 g, not more than 10.0; Moulds, CFU per 1 g, not more than 50, in the study - $1.0*10^2$. Thus, according to the results of the study (Table 3), it was found that, regardless of the shelf life, all model samples of the SFP during the specified shelf life comply with the microbiological parameters according to DSTU 4803:2007.

Conclusion. Thus, the study of the microbiological parameters of cricket flour for contamination with microorganisms that may be contained in the flour due to its production in another country, as well as transportation and storage for a long time, showed that cricket flour meets the sanitary and epidemiological safety requirements in force in Ukraine and intended for wheat flour. Therefore, it can be recommended for use in the technology of whipped flour semi-finished products.

In turn, no pathogenic microorganisms were detected in whipped flour semi-finished products with the addition of CF in the amount of 10.0% and stored for 7 days. Accordingly, it should be noted that CF is a product that will not affect the development of harmful microorganisms in the SFP during storage.

References

1. Bresciani, A.; Cardone, G.; Jucker, C.; Savoldelli, S.; Marti, A. Technological Performance of Cricket Powder (Acheta domesticus L.) in Wheat-Based Formulations. Insects 2022, 13, 546. https://doi.org/10.3390/insects13060546

2. Commission Implementing Regulation (EU) 2022/188 of 10 February 2022 authorising the placing on the market of frozen, dried and powder forms of Acheta domesticus as a novel food under Regulation (EU) 2015/2283 of the European Parliament and of the Council, and amending Commission Implementing Regulation (EU) 2017/2470 (Text with EEA relevance)

3. DSTU 4803:2007 Cakes and pastries. General technical conditions

4. Fombong, F.T.; Van Der Borght, M.; Vanden Broeck, J. Influence of Freeze-Drying and Oven-Drying Post Blanching on the Nutrient Composition of the Edible Insect Ruspolia Differens. Insects 2017, 8, 102

5. Fröhling, A., Bußler, S., Durek, J., &Schlüter, O. K.. Thermal impact on the culturable microbial diversity along the processing chain of flour from crickets (Acheta domesticus). Frontiers in Microbiology. 2020, 11(May), 1–13. https://doi.org/10.3389/fmicb.2020.00884

6. GSTU 46.004-99 Wheat flour. Specifications

7. Goyal, P., Chugh, L. K., &Berwal, M. K.Storage effects on flour quality of commonly consumed cereals. Journal of Applied and Natural Science. 2017, 9(1), 551–555. https://doi.org/10.31018/jans.v9i1.1228

8. Grispoldi, L., Karama, M., El-Ashram, S., Saraiva, C. M., García-Díez, J., Chalias, A., Barbera, S., &Cenci-Goga, B. T.Hygienic characteristics and detection of antibiotic resistance genes in crickets (Acheta domesticus) breed for flour production. Microbiology Research. 2021, 12(2), 503–512. https://doi.org/10.3390/microbiolres12020034

9. Iorgachova K.G., Makarova O.V., Kotuzaki O.M. Biscuit semi-finished product based on the flour of processed buckwheat products Grain products and compound feed No. 4 2010. 12-15 p.

10. Kobets, O. S. Use of dietary fibers in flour confectionery products / O. S. Kobets, V. F. Dotsenko, O. V. Arpul // Bakery and confectionery industry of Ukraine. – 2015. – No. 07–08 (128–129). – pp. 26–30.

11. Kravchenko M.F., Romanovska O.L. Innovative technologies of flour confectionery products from flour mixtures. Sustainable food chain and safety through science, knowledge and business: Scientific monograph. Riga, Latvia: "Baltija Publishing", 2023. 724p

12. Kravchenko, M., & Romanovska, O. Organoleptic analysis of biscuit semi-finished products with "health" flour and kerob powder. Proceedings of the Dmytro Motorny Tavri State Agro-Technological University, 2019, 19(1). Retrieved from https://oj.tsatu.edu.ua/index.php/pratsi/article/view/111

13. Klunder, H.C.; Wolkers-Rooijackers, J.; Korpela, J.M.; Nout, M.J.R. Microbiological aspects of processing and storage of edible insects. Food Control 2012, 26, 628–631

14. Maiyo, N.C.; Khamis, F.M.; Okoth, M.W.; Abong, G.O.; Subramanian, S.; Egonyu, J.P.; Xavier, C.; Ekesi, S.; Omuse, E.R.; Nakimbugwe, D.; et al. Nutritional Quality of Four Novel Porridge Products Blended with Edible Cricket (Scapsipedus icipe) Meal for Food. Foods 2022, 11, 1047. https://doi.org/10.3390/foods11071047

15. Matiyaschuk O.V., Furmanova Y.P., Pyanikh S.K. The use of amaranth flour in the production technology of biscuit semi-finished products. A scientific view of the future. Odesa: 2017, Issue 6. Volume 2, 106p.

16. Murugu, D.K.; Onyango, A.N.; Ndiritu, A.K.; Osuga, I.M.; Xavier, C.; Nakimbugwe, D.; Tanga, C.M. From Farm to Fork: Crickets as Alternative Source of Protein, Minerals, and Vitamins. Front. Nutr. 2021, 505, 704002

17. Melgar-Lalanne, G.; Hern'andez-´Alvarez, A.; Salinas-Castro, A. Edible insects processing: Traditional and innovative technologies. Compr. Rev. Food Sci. Food Saf. 2019, 18, 1166–1191

18. On the basic principles and requirements for the safety and quality of food products: Law of Ukraine dated December 23, 1997 No. 771/97-VR. URL: https://zakon.rada.gov.ua/laws/show/771/97-BP

19. The influence of gluten-free flours on the quality indicators of biscuit semifinished products / K. Iorgachova, O. Makarova, E. Kotuzaki. Cereal products and compound feed. Odesa, 2016. Vol. 64, Is. 4, P. 16–21

20. Voytenko O. Research on the possibility of replacing wheat flour with rice flour in the production of biscuit semi-finished products for patients with celiac disease // Scientific achievements of youth - solving the problems of human nutrition in the 21st century: program and materials of the 80th international conference. of science conf. of young scientists, graduate students and students (Kyiv, April 10–11, 2014). Kyiv: NUHT, 2014. Part 1. P. 32-33.

21. José Carlos Ribeiro, Carla Santos, Rui Costa Lima, Manuela E. Pintado, Luís Miguel Cunha Impact of defatting and drying methods on the overall liking and sensory profile of a cereal bar incorporating edible insect species. Future Food. Vol., 6 2022https://doi.org/10.1016/j.fufo.2022.100190