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ASSESSMENT OF THE MICROBIOLOGICAL STABILITY OF MARINATED GINGER STORED IN REFRIGERATED CONDITIONS

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Abstract: People use fresh, dried or marinated ginger in cooking, and some take it for their possible health benefits. Ginger may have anti-inflammatory, antibacterial, antiviral, and other healthful properties. Marinated ginger, mostly used for sushi on Polish market, is available in two variant forms: white and pink. Ginger is cut into thin slices, marinated in sweet and vinegar marinade and then undergoes thermal processing. The aim of the study was to assess the microbiological stability of marinated ginger. The best microbiological quality was characterized by ginger that had undergone a sterilization process. Although the initial number of lactic acid bacteria and fungi was the highest in ginger type C, the highest microbiological stability was also found in it.

Keywords: ginger, lactic acid bacteria, fungi, microbiological stability.

1. INTRODUCTION

Ginger is one of the most popular spices in every cuisine of the world. It is valued for its taste and aromatic and healing properties. It performs its function in the food industry and as a disease prevention agent. Ginger is characterized by a creamy or light yellow colour and a sharp, slightly lemon scent [Newerli-Guz and Pych 2012]. Ginger contains ingredients that vary according to its origin and whether the rhizomes are fresh or dry. Ginger oil consists of over 50 ingredients, mainly mono sesquiterpenes, curcumin, camphene and β-phellandrene. Literature data shows that ginger contains high levels of polyphenolic and flavonoid compounds with high antioxidant activity. The existence of these compounds in ginger extract may be responsible for its antioxidant and nephroprotective effects.

Ginger is believed to be beneficial in many oxidative stress-related disorders, including hypertension, pancreas and kidney disorders caused by diabetes, cancer progression and Alzheimer's disease. In traditional medicine, ginger has been used to treat, among others: headaches, nausea, febrile states, colds, arthritis, rheumatic

disorders [Kafeshani 2015; Tohma et al. 2017]. Fresh, candied, powder and marinated ginger is available on the Polish market. Many food and cosmetic products which include this plant can also be found. Marinated ginger, mostly used for sushi (often used as a measure for cleaning the palate) is available in two variant forms: white (natural) and pink (coloured). It is cut into thin slices, marinated in sweet and vinegar marinade and then undergoes thermal processing. Spices and sugar are used as additional ingredients improving taste, therefore salt, acetic acid and elevated temperature are considered to be the main factors increasing the microbiological safety of marinated products.

According to US Food and Drug Administration (FDA), ginger has been classified as „Generally Recognized as Safe, GRAS" and is approved for use in the food industry [Kulczyński and Gramza-Michałowska 2016]. Due to the possibility of storing marinated ginger for four weeks in refrigerated conditions, the aim of the study was to assess its microbiological stability.

2. MATERIAL AND METHODS

The research material was marinated ginger purchased from three different producers, from retail chains. The tests were conducted in three series. The composition of the tested products according to the manufacturer's declaration is listed in Table 1.

Table 1. The basic composition and storage conditions of investigated ginger samples

Ginger type	Basic components	Storage conditions
Product A produced in China	Ginger 56%, water, sugar, vinegar, salt 2%, acidity regulators: E260, E330; antioxidant: E300; sweetener: aspartame	Once opened, store in the fridge and use within 4 weeks
Product B produced in Thailand	Ginger 44%, water, cane vinegar, salt 2,9%, sweeteners: aspartame, saccharin; preservatives: sodium benzoate, sodium pyrosulphite	Once opened, store in the fridge and use within 1 month
Product C produced in China	Ginger 58%, water, salt 3,5%, acidity regulators: acetic acid, citric acid; preservative: potassium sorbate, sweetener: aspartame, saccharines, sucralose	After opening, store in the fridge, do not pour the marinade, consume within a month

Source: data contained in the product label.

Microbiological tests were carried out in the autumn-winter period on the day of purchase and on the 2nd, 7th, 14th, 21st, 28th day of storage. During the tests, ginger was stored in refrigerated conditions at 4°C ±2°C. The number of fungi is that cultivated on YGC medium with Merck's (Germany) chloramphenicol (incubation at temp. 25°C for 120 h). The number of lactic acid bacteria was that captured on Biomaxima (Poland) MRS medium (incubation at 37°C for 72 h). Microbiological determinations were carried out using the flooding method by sowing successive dilutions on appropriately selected media.

The following formula was used to determine microbiological stability [Steinka 2017]:

$$S = N_K / N_P < 1$$

where:

S – microbiological stability,
N_K – number of microorganisms after storage,
N_P – number of microorganisms before storage.

3. RESULTS AND DISCUSSION

On the basis of the conducted tests, different degrees of microbiological contamination of the tested products were found. Immediately after opening the products in ginger type C (where salt content was at the level of 3.5%) the highest number of fungi and lactic acid bacteria was found and amounted to 3.17 and 2.99 log cfu/g respectively. In the other ginger types (A and B) with salt content of 2% and 2.9%, respectively, these microorganisms were not been shown to be present (Tab. 2). In comparison, Sansuk, Punaiy and Rungraeng [2016] noted that in their study, the tested marinated ginger showed fungi count at the level of 2.31 log cfu/g.

The occurrence of lactic acid bacteria and fungi in ginger type C may have resulted from the tolerance of these microorganisms to relatively high salt concentrations [Lee 2004]. According to the literature data, a NaCl concentration of 12–15% is required to inhibit the growth of lactic acid bacteria, and at 3% salinity their activity is stimulated. Ginger type B contained the most preservatives with bacteriostatic and fungistatic properties [Krzysztofik et al. 2015], which may have contributed to the lack of the presence of the examined microorganisms in the initial phase of storage.

Table 2. Number of lactic acid bacteria and fungi present in ginger during 4-week storage period

Day of storage	Ginger A		Ginger B		Ginger C	
	lactic acid bacteria	fungi	lactic acid bacteria	fungi	lactic acid bacteria	fungi
	log jtk/g					
0	0	0	0	0	2.99	3.17
2	0	0	0	0	2.96	2.90
7	0	0	0	0	2.67	2.56
14	0	0	1.13	1.48	2.40	2.23
21	1.70	0	1.27	1.60	1.30	1.60
28	1.78	0	1.06	1.30	1.63	1.23

Source: own research.

After 14 days storage, while the number of examined microorganisms in ginger type C was reduced, in ginger type B, growth of fungi and lactic acid bacteria was observed, to the level of 1.48 and 1.13 log cfu/g respectively. No fungi were found during the entire storage period in product type A, which was the only one according to label, to be sterilized (Tab. 1). All tested products at the end of the storage period showed a number of the examined microorganisms, albeit at a level not exceeding the permissible limits set for fruit and vegetable products that were pasteurised or chemically preserved [Rozporządzenie Ministra Zdrowia z dnia 13 stycznia 2003].

Available literature data confirms that soluble ginger extracts have antifungal properties and are able to inhibit the growth of *Aspergillus niger*, *Aspergillus flavus* and *Cladosporium herbarum*. The strong inhibitory potential of ginger results from the fact that it contains more than 400 different compounds, such as zingeron, shogaoles and gingerols, sesquiterpenoids, which increase its antimicrobial effectiveness [Tagoe, Nyarko and Akpaka 2011]. In addition, some literature data indicates that acetic acid, one of the components found within the analysed products, is more effective against yeasts and bacteria than against moulds, while other studies show that acetic acid is usually more effective against yeasts and moulds than against bacteria [Lee 2004], as observed in these studies. However, the effect of acetic acid on lactic acid bacteria is small [Lee 2004].

Microbiological stability of the products is determined when the number of tested micro-organisms after storage is equal to or lower than the baseline or the number determined before storage [Steinka 2017]. Such a value was characterized by marinated ginger type C, for which the calculated S-value was below 1 (Tab. 3).

Table 3. S-parameter values for tested ginger

Type of ginger	Type of microrganisms	S-value
Ginger A	lactic acid bacteria	1.78
	fungi	0
Ginger B	lactic acid bacteria	1.06
	fungi	1.30
Ginger C	lactic acid bacteria	0.54
	fungi	0.39

Source: own research.

For ginger types A and B, the results obtained were characterized by values greater than unity for the tested types of microorganisms. Here, product A obtained a higher coefficient for lactic acid bacteria and zero for fungi. These results may indicate abnormalities resulting from improper handling during storage.

4. CONCLUSIONS

1. The best microbiological quality was characterized by ginger type A, which had undergone a sterilization process.
2. Although the initial number of lactic acid bacteria and fungi was the highest in ginger type C, the highest microbiological stability was found in it.

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