

## ASSESSMENT OF THE MICROBIOLOGICAL QUALITY OF SOY COLD CUTS

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**Abstract:** Soy products can make a good alternative to meat due to the absence of cholesterol, a more advantageous ratio of polyunsaturated to saturated acids, and a high content of full-value protein and dietary fibre. Soy is utilised to manufacture alternative meat products mainly in the form of a soy protein isolate, which usually contains 90% protein. The aim of this study was to assess the microbiological quality of selected soy cold cuts. No presence of *Escherichia coli* was found in the test products, while the lowest count of *Staphylococcus aureus* and mesophilic microorganisms was found in soy cold cuts with paprika.

**Keywords:** soy, soy cold cuts, soy protein isolates, microorganisms, microbiological contamination.

### 1. INTRODUCTION

The Polish market is observing a growth in the quantities of vegetarian and vegan products. It can be expected that the rising interest in these products among people in Poland will lead to the intensification in their production. One fifth of consumers aged 25–34 consume more vegetarian products today than in 2016, with almost 10% of people in this age bracket declaring that they follow a vegan or vegetarian diet [Jarocka 2017]. There is a growing range of products available for people following plant-only diets and for those who wish to diversify their daily diets by replacing meat with alternative soy-based products.

Soy products can make a good alternative to meat due to the absence of cholesterol, a more advantageous ratio of polyunsaturated to saturated acids, and a high content of full-value protein and dietary fibre. Soy has a beneficial effect on LDL concentration and on the functioning of the cardiovascular system, in particular if it replaces products of animal origin in the diet [Tyczewska et al. 2014;

Parol and Mamcarz 2015]. Despite the numerous benefits for the human body, soy and soy-based products may exhibit allergenic properties [Wilk 2017].

The soy utilised to manufacture alternative meat products is mainly used in the form of a soy protein isolate, textured soy protein and tofu. Soy protein isolate usually comprises 90% protein, and a small amount of fats and carbohydrates. In most cases, soy protein isolate is produced by extracting the protein from defatted and peeled soy flakes using water or a weak lye solution, thanks to which it retains the isoflavone content [Sadler 2004], while enzymatic treatment removes 96–100% of the main allergens from it [Wilk 2017]. Soy protein isolate is also subjected to heat treatment to deactivate trypsin inhibitors [Sadler 2004]. A diet rich in isoflavones may contribute to an increase in bone density and help prevent osteoporosis [Gheribi 2012]. Textured soy protein is produced from defatted soy flour, from which soluble carbohydrates were removed, with the remainder textured by centrifuging or pressing. The resulting product is subsequently dehydrated, which gives it a spongy texture. Both soy protein isolate and textured soy protein are used in such products as meatless sausages, cold cuts, nuggets and burger-like products. To confer the right organoleptic properties on the meat substitutes, flavourings are used in the production process so that the end product tastes like chicken, beef, lamb, ham, sausage or seafood [Sadler 2004; Malav et al. 2015].

The nutritional value of soy products increases their susceptibility to the growth of undesired microorganisms, particularly when they are not processed or stored properly [Madukwe, Eme and Okpara 2013]. Unfortunately, no requirements on the microbiological limits for vegetarian products have yet been introduced.

The aim of this study was to assess the microbiological quality of selected soy cold cuts.

## **2. MATERIAL AND METHODS**

The test material was soy cold cuts purchased in commercial chain stores, with the following flavours: poultry with green olives, salami, ham with green pepper, and ham with paprika (6 of each type). The analysed products came from different lots. The composition of the test meats is summarised in Table 1 according to the manufacturer's declaration.

The soy cold cuts were transported from the store to the microbiology laboratory in a thermally insulated bag, enabling the "cold distribution chain" continuity to be maintained. The samples were analysed immediately after reaching the laboratory. For the purpose of the tests, immediately after opening each package 20 g of the soy cold cut was removed, then homogenised with 180 ml of saline solution using a Stomacher.

**Table 1.** Basic composition and nutritional value of the analysed soy cold cuts

Cold cut type	Basic ingredients	Nutritional value in 100 g of product
With paprika	Water, frozen red paprika: 14.4%, <b>soy protein isolate: 9.6%</b> , rapeseed oil, wheat protein, starch, flavouring (soy), thickening agent: carrageenan, salt, citrus fibre, spice extracts and spices	Energy 606 kJ (145 kcal) fat 7.7 g carbohydrates 4.5 g dietary fibre 1.9 g protein 13.7% salt 2.2%
Poultry-flavoured with green olives	Water, <b>soy protein isolate: 12.3%</b> , rapeseed oil, wheat protein, starch, flavouring (soy), thickening agent: carrageenan, salt, green olives: 1.13% (green olives, water, salt, acidity regulator: citric acid, antioxidant: ascorbic acid), citrus fibre, spice extracts and spices	Energy 694 kJ (166 kcal) fat 9 g carbohydrates 4.5 g dietary fibre 2 g protein 15.8% salt 2%
Ham-flavoured with green pepper	Water, <b>soy protein isolate: 12.3%</b> , rapeseed oil, wheat protein, starch, flavouring (soy), thickening agent: carrageenan, salt, green pepper: 0.38% (green pepper, water, vinegar, salt), citrus fibre, spice extracts and spices	Energy 694 kJ (166 kcal) fat 9 g carbohydrates 4.5 g dietary fibre 2 g protein 15.8% salt 2%
Salami-flavoured	Water, <b>soy protein isolate: 7.23%</b> , rapeseed oil, wheat protein, starch, salt, thickening agent: carrageenan, saccharose, spices, flavouring (soy), spice extracts and citrus fibre	Energy 644 kJ (154 kcal) fat 6.9 g carbohydrates 5.1 g dietary fibre 2.1 g protein 16.8% salt 2%

Source: information provided on the product labels.

The following were assayed in the analysed products: total mesophilic microbial count (TMC) on Merck nutritional agar (incubation at 30°C for 72 h), *Staphylococcus aureus* count on *bioMérieux* Baird-Parker RPF selective substrate (incubation at 37°C for 48 h), *Escherichia coli* count on *bioMérieux* Coli ID selective substrate (incubation at 37°C for 48 h). The microbiological assays were performed using the pour plate method, applying consecutive dilutions to appropriately selected substrates.

Due to a lack of requirements concerning microbiological impurity limits for vegetarian products, the results were compared with the criteria for soy protein isolates, which constituted the primary ingredient for the test products (Tab. 1).

Descriptive statistics were used to analyse the results, specifically: mean value and standard deviation, median value and interquartile range, with the use of an Excel 2013 spreadsheet program.

### 3. RESULTS AND DISCUSSION

The test results indicate a range of microbiological conditions of the analysed soy cold cuts. Based on the results of the analysis, it was found that the highest levels of contamination by each analysed microorganism were characteristic of soy ham with green pepper, while the lowest contamination was observed in cold cuts with paprika (Tab. 2).

**Table 2.** Descriptive statistics for the determined microbe count in the test soy cold cuts

Cold cut type	<i>Staphylococcus aureus</i>		TMC	
	[log cfu/g]			
	M ±SD	Me ±IQR	M ±SD	Me ±IQR
With paprika	0.50 ±0.55	0.52 ±1.0	3.44 ±0.37	3.29 ±0.10
Poultry-flavoured with green olives	1.41 ±0.81	1.69 ±0.67	3.48 ±0.04	3.47 ±0.07
Ham-flavoured with green pepper	1.80 ±0.41	1.93 ±0.48	4.32 ±0.53	4.20 ±0.21
Salami-flavoured	1.53 ±0.84	1.70 ±0.78	4.18 ±1.28	4.62 ±1.86

TMC – total microbial count for aerobic mesophilic microbes, M – mean value, SD – standard deviation, Me – median, IQR – interquartile range.

Source: authors' own studies.

No presence of *Escherichia coli* was found in any of the tested products. The absence of *Escherichia coli* was also noted in the Monge et al. study [2000]. According to the available data, no presence of these bacteria should be found in soy protein isolates [Gandhi 2009; *Microbiological criteria for foodstuffs...*2014].

The highest mean count of *Staphylococcus aureus* (1.8 log cfu/g) was found in ham-flavoured cold cuts with green pepper. The lowest dispersion of results was also noted in this case (Tab. 2). While this product exhibited the highest mean count and median (Tab. 2), the highest maximum value of 2.41 log cfu/g was shown for the salami-flavoured meat. Fang, Chen and Kuo [1999] observed approx. 2% of samples where the quantity of *S. aureus* exceeded 6 log cfu/g, while Białasiewicz, Majczyna and Królasik [2006] did not detect these bacteria in the vegetarian products they analysed. *Staphylococcus aureus* were found in half of the paprika cold cut samples, with a count within the 0–1 log cfu/g range. Fang, Chen and Kuo [1999] found the presence of *Staphylococcus aureus* in 19.2% of the product samples whose main ingredient was soy. There result was 4 times lower than found in this study. This may indicate a lack of hygiene and improper handling during processing and storage.

The least aerobic mesophilic microorganisms (TMC) were found in soy cold cuts with paprika ( $Me \pm IQR = 3.29 \pm 0.10 \log \text{ cfu/g}$ ), while their count in the salami-flavoured meats was approx. a factor of log 1.3 higher (Tab. 2). In the test products, TMC ranged from 2.08 to 5.45 log cfu/g, while according to Białasiewicz, Majczyna and Królasik [2006], it was within the 3.49–5.91 log cfu/g range. Fang, Chen and Kuo [1999] observed approx. 25% of samples where the numbers of aerobic mesophilic microorganisms exceeded 6 log cfu/g, while in this study there were no products with this level of contamination. Due to the lack of requirements concerning maximum levels of microbiological contamination for vegetarian products, the soy cold cuts tested were compared with the criteria for soy protein isolates, as provided by Gandhi [2009]. Aerobic microbe counts exceeding 4 log cfu/g were found in approx. 67% of the analysed products. Considering the mean values, it can be stated that soy cold cuts with paprika and poultry-flavoured meats with green olives, whose main ingredient was soy protein isolate (Tab. 1), met the specified criteria (Tab. 2) [Ghandi 2009]. The lowest contamination level, found in the cold cut with paprika, may be linked to the nutritional value of these products, which was the lowest, compared to the other cold cut types (Tab. 1).

#### 4. CONCLUSIONS

1. No presence of *Escherichia coli* was found in the tested soy cold cuts.
2. The lowest numbers of *Staphylococcus aureus* and aerobic mesophilic microorganisms were found in soy cold cuts with paprika.
3. The results suggest that there exists a need to establish microbiological criteria for increasingly commonly consumed vegetarian products.

#### REFERENCES

- Białasiewicz, D., Majczyna, D., Królasik, J., 2006, *Ocena mikrobiologiczna produktów wegetariańskich*, Żywność. Nauka. Technologia. Jakość, vol. 1, no. 46, pp. 11–24.
- Fang, T.J., Chen, C.-Y., Kuo, W.-Y., 1999, *Microbiological Quality and Incidence of Staphylococcus aureus and Bacillus cereus in Vegetarian Food Products*, Food Microbiology, vol. 16, no. 4, pp. 385–391.
- Gandhi, A.P., 2009, *Quality of Soybean and Its Food Products – Review Article*, International Food Research Journal, vol. 16, pp. 11–19.
- Gheribi, E., 2012, *Znaczenie fitoestrogenów roślinnych w profilaktyce osteoporozy*, Postępy Fitoterapii, vol. 3, pp. 192–196.

- Jarocka, H., 2017, *Millenialsi lubią zdrowo jeść; rośnie liczba vegetarian, wegan i fleksitarian*, <http://www.portalspozywczy.pl/handel/wiadomosci/millenialsi-lubia-zdrowo-jesc-rosnie-liczba-vegetarian-wegan-i-fleksitarian.140400.html> (08.02.2017).
- Madukwe, E.U., Eme, P.E., Okpara, C.E., 2013, *Nutrient Content and Microbial Quality of Soymilk-Carrot Powder Blend*, *Pakistan Journal of Nutrition*, vol.12, no. 2, pp. 158–161.
- Malav, O.P., Talukder, S., Gokulakrishnan, P., Chand, S., 2015, *Meat Analog: A Review*, *Critical Reviews in Food Science and Nutrition*, vol. 55, no. 9, pp.1241–1245.
- Microbiological Criteria for Foodstuffs.*, 2014, Final Draft. GSO /FDS 1016 / 2014.
- Monge, R., Arias, M.L., Alfaro, T., Jiménez, M., 2000, *Nutritional and Microbiological Profile of Soybean Sausages Available in Costa Rica*, *Archivos Latinoamericanos de Nutrición*, vol. 50 no. 2, pp. 142–7.
- Parol, D., Mamcarz A., 2015, *Diety roślinne w kontekście chorób układu sercowo-naczyniowego*, *Folia Cardiologica*, vol. 10, no. 2, pp. 92–99.
- Sadler, M.J., 2004, *Meat Alternatives – Market Developments and Health Benefits*, *Trends in Food Science & Technology*, vol. 15, pp. 250–260.
- Tyczewska, A., Gracz, J., Twardowski, T., Małyńska, A., 2014, *Soja przyszłością polskiego rolnictwa?* *Nauka*, vol. 4, pp. 121–138.
- Wilk, M., 2017, *Soja źródłem cennych składników żywieniowych*, *Żywność. Nauka. Technologia. Jakość*, vol. 24, no. 2(111), pp. 16–25.