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THE ASSESSMENT OF THE SENSORY QUALITY OF THE SAUERKRAUT FROM ORGANIC AND CONVENTIONAL FARMING

Summary

Sauerkraut is a popular food product in Poland. The consumption of sauerkraut, according to different sources, ranges from 4 to 5 kg/person/year. The objective of this study was to provide information on the nutritional and health properties of sauerkraut and to assess some selected distinctive features of sensory quality of sauerkraut from organic and conventional farming. The hypothesis of the study assuming that organic sauerkraut has a better tastiness, has been verified positively. The assessed types of sauerkraut have significantly different taste and aroma, the consumers have valued the organic sauerkraut significantly higher than the sauerkraut from conventional farming. No statistically significant difference was indicated in the assessment of sauerkraut from organic farming and conventional, only the aroma was statistically significant difference
***Key word**: sauerkraut, sensory evaluation, consumer, organic food*

KONSUMENCKA OCENA JAKOŚCI SENSORYCZNEJ KAPUSTY KISZONEJ Z PRODUKCJI EKOLOGICZNEJ I KONWENCJONALNEJ

Streszczenie

Kapusta kiszona jest bardzo popularnym produktem żywnościowym w Polsce. Spożycie to kształtuje się według różnych źródeł od 4 do 5 kg/osobę/rok. Celem pracy było przybliżenie wiedzy na temat właściwości odżywczych i zdrowotnych kapusty kiszonej oraz ocena wybranych wyróżników jakości sensorycznej kapusty kiszonej otrzymanej z kapusty uprawianej w sposób ekologiczny i konwencjonalny. Postawiona w pracy hipoteza o wyższej smakowitości ekologicznej kapusty kiszonej została częściowo zweryfikowana pozytywnie. Oceniane kapusty kiszone znacznie różniły się smakiem i aromatem, zdecydowanie wyżej konsumenci ocenili kapustę z produkcji ekologicznej. Nie stwierdzono statystycznie istotnej różnicy w ogólnej ocenie kapusty kiszonej ekologicznej i konwencjonalnej, jedynie aromat był cechą statystycznie różnicującą.
***Słowa kluczowe**: kapusta kiszona, ocena sensoryczna, konsument, żywność ekologiczna*

1. Introduction

In the recent years, the consumers have been paying more and more attention to the quality of food. However, the growing awareness of the consumers regarding the nutritional quality and value of food has become a new factor. Increased demand for organic food, which is considered to be healthy, tasty and of high nutritional value, has been observed. The production of organic food based on special norms, is regarded as environment-friendly.

The cruciferous vegetables (*Brassiceae)* belong to the plant products which belong the basic food products for the citizens of many European and Asian countries. The vegetables of this family are produced in various agricultural systems and with the use of various methods.

The cruciferous vegetable family (*Brassiceae)* include a great number of vegetables, such as cabbage, cauliflower or kale. There are numerous varieties of cabbage, but one of the greatest significance is the headed cabbage, including the following varieties: the white cabbage (*Brassicaoleracea*. L. var. *capitata* f. *alba*), red cabbage (*B. oleracea*var. L. *capitata* f. *rubra*) and Brussel sprout (*B. oleracea* L. var. *gemmifera* Zenk.). Cabbage belongs to the essential elements of a human diet, especially in Europe and Asian countries. The vegetables of *Brassiceae* species have been gaining popularity as they contain numerous compounds which have a positive influence on the human health, including glucosinolates and polyphenols [8, 19]. The glucosinolates are accompanied by myrosinase, an enzyme responsible for the glucosinolates hydrolysis to numerous bio-active compounds such as thiocyanates and isothiocyanates, which inhibit the growth of microorganisms and have Anti-carcinogenic properties [11]. The most significant polyphenolic compounds are the derivatives of quercetin and kaempferol [25]. The cruciferous vegetables are also the source of vitamins C and E, β-Carotene, lutein and DL-α-tocopherol. It has been proved that the compounds are powerful antioxidants and they protect cells against oxidative stress. Therefore, they may prevent from numerous chronic diseases such as neoplasms, cardiovascular diseases and diabetes [19].

The presence of bio-active compounds in the *Brassiceae* family and their anti-oxidant properties depends on numerous factors, including the genetic traits (the species, variety, part of the plant), climate conditions, the soil composition and fertility, agronomic treatments, the harvesting conditions, storage and processing [1, 9, 23]. The common methods of the processing of *Brassiceae* include blanching, boiling and freezing. One of the most commonly used methods of cabbage processing is natural fermentation. Sauerkraut is a very popular and often consumed vegetable in Poland, its consumption is about 4 kg/year/person [26]. The cabbage both from organic and conventional farming is used for the production of sauerkraut.

There is generally believed that organic food is more tasty and healthy as no synthetic fertilisers, chemical plant health products as pesticides and herbicides, are used in the production process, whereas the cabbage processing involves natural additives [27]. The processing itself is a subject to development and the organic sauerkraut has been present on the market for several years.

The objective of the study was the assessment of selected distinctive features of sensory quality of sauerkraut from organic and conventional farming.

The hypothesis has been presented in this study is that organic sauerkraut has a higher level of tastiness than sauerkraut from the conventional farms.

Cabbage fermentation technology

The technology of cabbage fermentation is very simple. The ingredients used in the fermentation process are cabbage, common salt and water. The certified cabbage from organic farms is used in the production of organic sauerkraut and the fermentation process runs similarly to the sauerkraut made from the conventional cabbage.

A fresh headed cabbage *Brassica oleracea* L. var. *capitata* is the best variety of cabbage to be used for fermentation. A stored cabbage loses its bio-active compounds depending on the storage conditions and period. The studies have confirmed that even the storage of cabbage in controlled atmosphere causes a decrease of the amount of vitamin C and chlorophyll [10, 14, 31]. The research has shown that the cabbage from organic farming contained more bio-active compounds than the cabbage from conventional farming, but the storage stability of those compounds in different farming systems was diversified [6].

The fermentation process involves the bacteria present on the surface of crushed cabbage leaves and bacteria present in the air of the room where the process takes place. The fermentation is started by the heterofermentative bacteria of lactic acid, such as *Leuconostoc mesenteroides* which produces mainly acetic acid and lactic acid. Further fermentation takes place with the use of *Lactobacillus plantarum* [3, 32].

The spontaneous fermentation might cause differences in the composition of microbiota, which may be the reason of the quality change of sauerkraut. For the standardization process the starter cultures are used in the industrial production [30]. Most frequently they include the bacteria cultures isolated from sauerkraut, such as *Leuconostoc mesenteroides*, *Lactobacillus plantarum*, *Lactobacillus casei* and *Lactococcus lactis*. The studies with these starter cultures have been conducted in China, among other countries. The bacteria used in the industrial fermentation were isolated from sauerkraut which underwent a traditional fermentation process. This sauerkraut should be differentiated from kimchi, the regional sauerkraut produced in natural method of fermentation in some of the regions of China, but mainly in Korea and Taiwan [4, 24]. In the sauerkraut produced with the use of starter cultures, the fermentation process is controlled, and the quality of product is standardized. In the spontaneous fermentation the quality depends on many factors [30].

In order to improve the taste and the aroma, the additions of dill, carrots and apples are used in the fermentation process. These additives are more often used in the organic production of sauerkraut. Their role is to improve the taste of the food. A great number of spices also have a therapeutic effect and facilitates digestion. However, the microbiological purity of these spices is a great problem. The collection of spices and preparation technology are traditional and fosters the habitation of bacteria, mould and fungi in the dried plants mostly. The general amount of microorganisms in spices may come up to 10^9 in 1 g. In the industrial production of spices the radiation sterilization is used [4, 24]. An excessive addition of spices in the organic production of sauerkraut may interrupt the spontaneous fermentation and result in a “wild” fermentation.

The direction of fermentation and the quality of the fermented cabbage are also influenced by the amount of salt. The research conducted in China has found out that the amount of lactic acid has increased with the increase of salt concentration. The higher concentrations of salt successfully inhibited the growth of fungi and *E. coli*. For comparison, a high concentration of salt slowed down the maturity of cabbage and inhibited the metabolism of the lactic acid bacteria [33].

The content of sodium in sauerkraut is essential as an excessive amount of sodium is associated with an increased blood pressure and it is a risk factor for cardio-vascular diseases. This is the reason for the calls of the health organizations and consumers organizations for reducing the amount of sodium in food. The actions concerning this problem are also directed towards the process of cabbage fermentation. The studies have shown that the amount of salt in sauerkraut may range from 15.0 to 22.5 g kg-1 NaCl [24]. Numerous experiments resulting in the reduction of the amount of NaCl in the cabbage fermentation process have shown that the reduction of the amount NaCl to 5% and the addition of various chemical compounds such as KCl, HCl, $MgSO_4$, $SiSO_2$ result in the reduction of the salt amount, however it changes the taste of the sauerkraut, which must be concealed by spices. Moreover, the cabbage becomes less crunchy [32].

Another direction of research on cabbage fermentation were actions aiming to enrich this product with selenium compounds. The addition of selenium is only used in conventional sauerkraut production (11.6 µg/100 g fresh cabbage). The role of selenium is to prevent from chronic diseases related to oxidative stress. According to Penas et al, the addition of selenium salt has increased the content of glucosinolates and se-methylselenocysteine improving the antioxidative ability and potential anti-inflammatory properties of sauerkraut [18].

Health properties and the presence of anti-nutrients in sauerkraut

The health properties of sauerkraut are connected first of all with the content of such compounds like polyphenols, vitamins C, E, K, carotenoids, flavonoids, sulphides, fiber, selenium, zinc, manganese, potassium, iron and other. The compounds characterized with high antioxidant and antiradical activity play particular role among these compounds.

The sauerkraut processing procedures using the increased temperature such as blanching, pasteurization, sterilization cause a decrease of the antioxidant properties of sauerkraut. On the other hand, the fermentation of sauerkraut causes an increase of the content of antioxidant compounds and vitamin C [5,17].

Glucosinolates draw the biggest attention out of all the substances occurring in cruciferous vegetables. Until not long ago these compounds had been considered as anti-nutrients [13, 29].They have a very complex chemical structure, over 200 compounds have been discovered until now, and they hydrolyze to isothiocyanates, thiocyanate, nitriles and indoles. These compounds have a very unpleasant taste and smell, they cause irritation of the alimentary tract, they also have goitrogenic properties. They get decomposed during cooking and they evaporate with steam. The latest research has confirmed that glucosinolates have the ability to inhibit cancer processes. During fermentation the decomposition of glucosinolates takes place and the intensity of this process depends on the fermentation temperature and the population of lactic acid bacteria [15]. Fresh and sour red cabbage and fresh white cabbage and sauerkraut indicate the highest antioxidant activity out of cruciferous vegetables [12].

Besides the anticancer effect, sauerkraut has a positive influence on blood pressure, immunity system, it enhances metabolism due to the content of fiber, it has weight loss properties, reduces the level of cholesterol and has effects on lipid metabolism, it increases iron absorption [26].

Following to the microorganisms' functioning in food, free amines having strong effects on the organism, called biogenic amines, come into being. This process also occurs during sauerkraut fermentation. It has been found out that histamine is created in sauerkraut in the biggest amount. The content of histamine in fresh vegetables depends on the type, species, degree of maturity and on processing and storing of the products. Histamine indicates psychoactive and vasoactive properties which can induce toxicological effects.

Histamine in high concentration causes headache. Other biogenic amines include: tyramine inducing migraines and arterial hypertension, spermine and spermidine which are less toxic, however they enhance the negative effect of histamine. Studies have confirmed that the microorganisms used in the fermentation process have effect on the amount and type of the created amines. The total concentration of the biogenic amines in sauerkrauts was lower when the fermentation was conducted with *L.mesenteroides*rather than with *L. plantarum* [16].

2. Material and methods

The material for studies was the sauerkraut from organic and conventional farming. The organic sauerkraut came from the organic food store and the conventional sauerkraut was bought at a discount store. In both cases the cabbage was subjected to fermentation in special fermentation tanks, next it was put to jars in order to undergo pasteurization. The organic product was properly marked with a control unit certificate. The conventional product had the basic information regarding the product and the supplier, however, no information was given whether any other additions had been used in the fermentation process, such as acid addition, which is a common procedure in the conventional farming and it provides microbiological protection against the growth of any undesired microorganisms.

The samples of sauerkraut from the organic and conventional farming were coded. The packaging compliance was assessed in terms of the requirements of the Regulation of the Ministry of Agriculture and Rural Development on Labelling of Foodstuffs for Particular Nutritional Purposes of 23rd December 2014 and of The Act of 25 August 2006 on Food and Nutrition Safety [20, 22, 28]. The labels of the examined products included the basic information such as: name of the product, net weight, name of the manufacturer, batch number, ingredients and minimum expiry date, whereas the organic sauerkraut also had the relevant organic food certification marks. All captions were in Polish, they were legible and permanent. There was no information about the presence of allergens on the labels of either the organic or conventional product.

A sensory analysis was carried out by means of a five point grading scale for quality factors. The following parameters were assessed: the appearance, colour, aroma, taste [2]. The scaling method which allowed for a digital expression of the examined parameters (taste, aroma, appearance, colour) was used for examining the quality of the sauerkraut, taking into account the ranking scale of particular factors. The organoleptic analysis was performed according to Five Point Scale(1 point means disqualification whereas 5 means very good). MS Excel sheet and Statistica 12 package for data statistical analysis were used for the calculation of the final score of the organoleptic analysis. The following significance coefficients were assumed: 0.5 – taste; 0.3 – aroma; 0.1 – appearance; 0.1 – colour [7].

3. Test results

A consumer-like assessment of sauerkrauts has been performed by 58 young women aged 20-26. The persons assessing the sauerkraut did not eat or drink directly before tasting, nor did they smoke cigarettes, which could have affected their objective sensory perception. The samples, all formerly cooled down to 6°C, were served on white plates directly before the assessment. Following to the assessment the average score from 1.25 to 5 points was awarded for the organically farmed sauerkraut whereas the score from 1.25 to 4.5 was awarded to the conventionally farmed sauerkraut.

The results were subjected to statistical analysis, by means of one factor variance analysis, at p=0.05 significance level, using the data statistical analysis package Statistica 12.

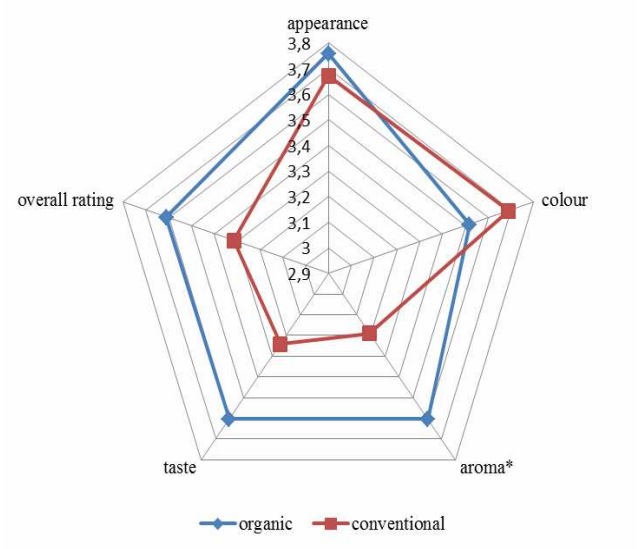
Tab. 1. The sensory quality assessment of sauerkraut from organic and conventional farming
Tab. 1. Jakość sensoryczna kapusty kiszonej z rolnictwa ekologicznego i konwencjonalnego

Subject of the evaluation	**Organic** [$\overline{X}$ ±SD]	**Conventional** [$\overline{X}$ ±SD]	Grade
appearance	3.76 ±1.16	3.67±1.15	0.1
colour	3.52±1.16	3.69±0.90	0.1
aroma	3.60±1.09*	3.19±1.08	0.3
taste	3.60±1.23	3.24±1.30	0.5
overall rating	**3.61±0.97**	**3.31±0.92**	
*differences insignificant			

Source: compiled on the basis of own results / Źródło: opracowane na podstawie badań własnych

It is difficult to discuss the results obtained from the study due to the fact that only a few research in terms of the sensory assessment of sauerkraut from organic and conventional farming has been conducted so far. Studies have shown that sauerkraut from organic and conventional production has obtained very similar assessment ratings. The

taste and aroma of sauerkraut was significantly better evaluated in the case of sauerkraut [21].



*differences insignificant

Source: compiled on the basis of own results / Źródło: opracowane na podstawie badań własnych

Fig. 1. Quality factors of the organoleptic assessment of sauerkraut from organic and conventional farming
Rys. 1. Wyróżniki jakościowe organoleptycznej oceny kiszonej kapusty z rolnictwa ekologicznego i konwencjonalnego

The assessed sauerkrauts significantly differed from each other in terms of taste and aroma, the consumers valued the sauerkraut from organic farming remarkably higher. A very strong increasing correlation (0.994) has been confirmed between the organic and conventional products (Tab. 1, Fig. 1). No statistically significant difference ($p<0.05$) was indi-cated in the assessment of sauerkraut from conventional and organic farming ($p=0.094$). However aroma was statistically significant difference ($p=0.042$, $F=4.20$), the same like in research of Rembiałkowska [21].

4. Summary

Sauerkraut is a valued food product in Poland and in many countries of Europe and Asia. This thesis presents the actual status of knowledge about the dietary and nutritional importance of sauerkraut. The difference between the organic and conventional sauerkraut lies in the method of its fermentation. Organic producers always use the natural method of cabbage fermentation and conventional producers usually use starter cultures in the fermentation process.

The approach to anti-nutrients contained in cruciferous vegetables has changed following to the research carried out by many scientists. Sauerkraut is characterized by the higher content of vitamin C than fresh cabbage. In the course of myrozinase glucosinolates get decomposed to isothiocyanates, thiocyanates, nitriles and indoles. The fermentation process increases the content of these compounds. It has been indicated that the products of glucosinolates decomposition, together with polyphenols, determine the antioxidant properties of sauerkrauts.

Presently, the research on sauerkraut is oriented on increasing the sauerkraut value by reducing the use of salt during the fermentation process and using the addition of other substances, such as selenium, which might cause that sauerkraut would be considered as functional food.

Polish consumers highly rate sauerkraut and they use it for fresh meals, sauerkraut soups and for the traditional dish called *bigos*.

Sauerkraut obtained from the cabbage grown on organic and conventional farms was subjected to assessment in this study. Young women valued the sauerkraut from organic farming higher, pointing at its better taste and aroma. They also paid attention whether the texture that is crispiness of the organic sauerkraut was higher.

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