IRSTI 65.59.15 https://doi.org/10.58805/kazutb.v.3.24-510

ENHANCING QUALITY AND SHELF LIFE OF ORGANIC SAUSAGES WITH PURSLANE POWDER

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This study investigates the effects of adding purslane powder (Portulaca oleracea) to organic sausages made from organic beef, focusing on physicochemical properties, sensory characteristics, and microbiological stability. The use of natural additives is crucial in organic sausage production due to restrictions on synthetic preservatives and sodium nitrite. Samples were prepared with 0.8%, 1.2%, and 1.4% purslane powder and compared to a control without purslane. Results showed that purslane powder significantly improved moisture retention, with the highest levels observed in the 1.2% and 1.4% samples. pH values remained stable across all samples, indicating effective acidity regulation. Water activity (aw) values were consistent, ensuring microbiological safety. The total viable count (TVC) was significantly lower in samples with purslane, particularly at 1.2% and 1.4% concentrations, compared to the control. Sensory analysis indicated that the sample with 1.2% purslane maintained high scores similar to the control, while the 1.4% sample exhibited a bitter taste and greenish tint, negatively affecting its sensory attributes. The use of organic beef aligns with consumer demand for natural and healthy products, providing high-quality protein without synthetic additives. Purslane powder, known for its antioxidant and antimicrobial properties, proved to be an effective natural additive for improving the quality and shelf life of organic sausages. The optimal concentration of 1.2% purslane is recommended, offering a balance between enhanced physicochemical properties and favorable sensory characteristics. This study supports the use of natural additives in organic meat products, promoting healthier and more sustainable food options.

Keywords: organic sausages, purslane powder, physicochemical properties, sensory analysis, microbiological stability, natural additives.

УЛУЧШЕНИЕ КАЧЕСТВА И СРОКА ГОДНОСТИ ОРГАНИЧЕСКИХ КОЛБАС С ПОМОЩЬЮ ПОРОШКА ПОРТУЛАКА

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Исследование изучает влияние добавления порошка портулака (Portulaca oleracea) в органические колбасы, изготовленные из органической говядины, с акцентом на физико-химические свойства, сенсорные характеристики и микробиологическую стабильность. Использование натуральных добавок имеет решающее значение в производстве органических колбас из-за ограничений на синтетические консерванты и нитрит натрия. Были подготовлены образцы с 0,8%, 1,2% и 1,4% порошка портулака и сравнены с контрольным образцом без портулака. Результаты показали, что порошок портулака значительно улучшил удержание влаги, при этом самые высокие уровни наблюдались в образцах с 1,2% и 1,4%. Значения pH оставались стабильными во всех образцах, что указывает на эффективное

регулирование кислотности. Значения активности воды (aw) были постоянными, что обеспечивало микробиологическую безопасность. Общее количество жизнеспособных бактерий (КМАФАнМ) было значительно ниже в образцах с портулаком, особенно при концентрациях 1,2% и 1,4%, по сравнению с контрольным образцом. Сенсорный анализ показал, что образец с 1,2% портулака сохранял высокие оценки, аналогичные контрольному, тогда как образец с 1,4% портулака имел горький вкус и зеленоватый оттенок, что отрицательно сказалось на его сенсорных характеристиках. Использование органической говядины соответствует потребительскому спросу на натуральные и полезные продукты, обеспечивая высококачественный белок без синтетических добавок. Порошок портулака, известный своими антиоксидантными и антимикробными свойствами, оказался эффективной натуральной добавкой для улучшения качества и срока годности органических колбас. Рекомендуется оптимальная концентрация 1,2% портулака, обеспечивающая баланс между улучшенными физико-химическими свойствами и благоприятными сенсорными характеристиками. Это исследование поддерживает использование натуральных добавок в органических мясных продуктах, способствуя продвижению более здоровых и устойчивых вариантов питания.

Ключевые слова: органические колбасы, порошок портулака, физико-химические свойства, сенсорный анализ, микробиологическая стабильность, натуральные добавки.

ПОРТУЛАК ҰНТАҒЫ ҚОСЫЛҒАН ОРГАНИКАЛЫҚ ШҰЖЫҚТАРДЫҢ САПАСЫ МЕН САҚТАУ МЕРЗІМІН ЖАҚСАРТУ

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Зерттеу физикалық-химиялық қасиеттерге, сенсорлық сипаттамаларға және микробиологиялық тұрақтылыққа назар аудара отырып, органикалық сиыр етінен жасалған органикалық шұжықтарға портулак ұнтағын (Portulaca oleracea) қосудың әсерін зерттейді. Табиғи қоспаларды қолдану синтетикалық консерванттар мен натрий нитритіне шектеулерге байланысты органикалық шұжық өндірісінде өте маңызды. Үлгілер 0,8%, 1,2% және 1,4% портулак ұнтағымен дайындалды және портулаксыз бақылаумен салыстырылды. Нәтижелер портулак ұнтағы ылғалдың сақталуын айтарлықтай жақсартқанын көрсетті, ең жоғары деңгейлер 1,2% және 1,4% үлгілерде байқалды. pH мәндері барлық үлгілерде тұрақты болып қалды, бұл қышқылдықтың тиімді реттелуін көрсетеді. Су белсенділігінің (aw) көрсеткіштері микробиологиялық қауіпсіздікті қамтамасыз ете отырып, сәйкес болды. Жалпы өміршеңдік көрсеткіші (TVC) портулак сынамаларында айтарлықтай төмен болды, әсіресе бақылаумен салыстырғанда 1,2% және 1,4% концентрацияда. Сенсорлық талдау көрсеткендей, 1,2% портулак сынамасы бақылауға ұқсас жоғары балл жинады, ал 1,4% сынамада ащы дәм мен жасыл реңк байқалды, бұл оның сенсорлық қасиеттеріне теріс әсер етті. Органикалық сиыр етін пайдалану тұтынушылардың табиғи және пайдалы өнімдерге деген сұранысына сәйкес келеді, синтетикалық қоспаларсыз жоғары сапалы ақуызды қамтамасыз етеді. Антиоксиданттық және микробқа қарсы қасиеттерімен танымал портулак ұнтағы органикалық шұжықтардың сапасы мен сақтау мерзімін жақсарту үшін тиімді табиғи қоспа болып шықты. Жақсартылған физика-химиялық қасиеттері мен қолайлы сенсорлық сипаттамалары арасындағы тепе-теңдікті қамтамасыз ететін 1,2% портулактың оңтайлы концентрациясы ұсынылады. Бұл зерттеу органикалық ет өнімдерінде табиғи қоспаларды қолдануды қолдайды, бұл тағамның пайдалы және тұрақты нұсқаларын жасауға ықпал етеді.

Түйін сөздер: органикалық шұжықтар, портулак ұнтағы, физика-химиялық қасиеттері, сенсорлық анализі, микробиологиялық тұрақтылығы, табиғи қоспалары.

Introduction. In recent years, the interest in organic food products has significantly increased due to their presumed health benefits and lower environmental impact. One of the promising directions in the organic production of meat products is the use of natural additives, such as plant extracts and powders, to improve the quality and safety of the products. In this context, purslane powder (Portulaca oleracea) is of particular interest, as it possesses a range of beneficial properties, including antioxidant and antimicrobial activity [1].

The global market for organic food has been experiencing steady growth, driven by consumer awareness and demand for healthier and more environmentally friendly food options. According to recent reports, the market for organic products is projected to continue expanding, with significant investments being made in research and development of organic farming and production techniques [2, 3].

Natural additives have gained considerable attention in the food industry due to their potential to enhance food quality and safety. Plant-based extracts and powders, in particular, are being extensively studied for their bioactive compounds that can act as natural preservatives and health enhancers. Studies have shown that these natural additives can improve the sensory attributes of food, extend shelf life, and reduce the need for synthetic additives [4,5].

Purslane (Portulaca oleracea) is a succulent plant widely recognized for its nutritional and medicinal properties. It is rich in omega-3 fatty acids, vitamins, minerals, and bioactive compounds such as phenolics and flavonoids. Previous research has highlighted its antioxidant properties, which can help in preventing oxidative deterioration of food products. Moreover, its antimicrobial activity has been reported to inhibit the growth of various foodborne pathogens, making it a promising natural additive for food preservation [6,7].

Water activity (aw) is a crucial parameter in determining the shelf life and safety of food products. It measures the availability of free water for microbial growth and chemical reactions. High water activity in food can lead to the proliferation of spoilage and pathogenic microorganisms, which adversely affects the product's quality and safety. Therefore, controlling water activity is essential in the production of meat products, especially organic ones, to ensure their microbiological stability and extend their shelf life [8,9].

The use of natural additives like purslane powder in meat products can potentially regulate water activity and enhance antimicrobial properties. Purslane contains phenolic compounds and flavonoids that exhibit significant antimicrobial potential, which can contribute to maintaining the microbiological quality of the product [10].

The aim of this study is to comprehensively evaluate the effect of purslane powder on water activity and antimicrobial activity in organic sausages. The determination of the influence of different concentrations of purslane powder on water activity (aw) in organic sausages was measured using the AquaLab 4TE analyzer (METER Group, USA) to ensure accuracy and reliability of the results. The analysis of changes in physicochemical indicators (moisture, pH) and their impact on the microbiological stability of the products during storage was conducted. The moisture content and pH in sausage samples with added purslane powder were analyzed (Tango-R FT-NIR spectrometer, Bruker, Germany), as well as their changes during storage (Table 1).

Materials and methods. Moisture Content and pH Measurement. The moisture content and pH of the sausage samples were determined using the Tango-R FT-NIR spectrometer (Bruker, Germany). Approximately 10 grams of each sausage sample were homogenized, and the homogenate was analyzed using the FT-NIR spectrometer. This technique allows for rapid and non-destructive analysis of moisture and pH by measuring the near-infrared absorption spectra of the samples. The instrument was calibrated using standard reference materials to ensure accuracy. The moisture content and pH values were obtained from the spectral data using the instrument's software.

Water Activity (aw) Measurement. Water activity (aw) of the sausage samples was measured using the AquaLab 4TE water activity meter (METER Group,

USA). Approximately 2 grams of each sample were placed in the sample cup, ensuring that the sample surface was level and free from air pockets. The sample cup was then placed in the measurement chamber of the AquaLab, and the aw value was recorded once the reading stabilized. The instrument was calibrated regularly using standard calibration salts (aw 0.760 and aw 0.920) to ensure accuracy and reliability of the results.

Antimicrobial Activity Analysis. To evaluate the antimicrobial activity of the purslane powder in the sausage samples, microbiological analysis was conducted. The total viable count (TVC) was assessed using Compact Dry plates (Nissui Pharmaceutical Co., Ltd., Japan). Sausage samples were homogenized in sterile saline solution and serially diluted. An aliquot (1 ml) of the diluted sample was applied to the Compact Dry plate and spread evenly. The plates were incubated at 35°C for 48 hours, after which the colony-forming units (CFU) were counted. The results were expressed as log CFU per gram of sausage.

Statistical Analysis. All experiments were conducted in triplicate, and the results were expressed as mean ± standard deviation. Statistical analysis was performed using ANOVA (Analysis of Variance) to determine the significance of differences between the control and experimental samples. A p-value of less than 0.05 was considered statistically significant.

Results and discussion. The moisture content of the sausage samples showed a general decrease over the storage period for both the control and experimental samples. However, the experimental samples with purslane powder exhibited higher moisture retention compared to the control. For instance, at 9 days, the control sample had a moisture content of 54.9%, whereas the samples with 0.8%, 1.2%, and 1.4% purslane powder had moisture contents of 57.2%, 58.7%, and 58.9%, respectively. This suggests that the addition of purslane powder helps in retaining moisture in the sausages, which could be beneficial for the texture and juiciness of the product (table 1).

Table 1 - Physicochemical parameters of control and experimental sausage samples with added purslane powder

Parameter	Storage, days	Control	Experiment 1 (0.8% purslane)	Experiment 2 (1.2% purslane)	Experiment 3 (1.4% purslane)
Moisture, %	1 day	63,67 ± 0,05	65,42 ± 0,06	67,34 ± 0,04	67,8 ± 0,05
	3 days	57,2 ± 0,13	59,1 ± 0,11	61,3 ± 0,10	62,7 ± 0,09
	6 days	55,6 ± 0,12	57,6 ± 0,12	59,3 ± 0,12	59,8 ± 0,10
	9 days	54,9 ± 0,13	57,2 ± 0,12	58,7 ± 0,11	58,9 ± 0,08
pH	1 day	6,37 ± 0,05	6,17 ± 0,12	6,15 ± 0,11	6,10 ± 0,09
	3 days	6,33 ± 0,06	6,19 ± 0,09	6,17 ± 0,08	6,13 ± 0,11
	6 days	6,27 ± 0,06	6,25 ± 0,05	6,27 ± 0,09	6,19 ± 0,06
	9 days	6,21 ± 0,06	6,24 ± 0,06	6,26 ± 0,12	6,21 ± 0,09
Water Activity (aw), c.u.	1 day	0,824± 0,003	0,825± 0,003	0,826± 0,003	0,825± 0,003
	3 days	0,827± 0,002	0,827± 0,002	0,827± 0,002	0,827± 0,002
	6 days	0,819± 0,002	0,824± 0,000	0,824± 0,002	0,824± 0,002
	9 days	0,816± 0,002	0,819± 0,002	0,821± 0,002	0,824± 0,002

The pH levels of the sausage samples decreased slightly over the storage period for all samples. The control sample started with a pH of 6.37 on day 1 and decreased to 6.21 by day 9. The experimental samples with purslane powder showed a similar trend, with initial pH values slightly lower than the control. For example, the sample with 1.4% purslane powder had a pH of 6.10 on day 1, which remained relatively stable, ending at 6.21 on day 9. The slightly lower initial pH in the experimental samples could

be attributed to the acidic nature of the phenolic compounds in purslane powder.

The water activity (aw) values for all samples remained relatively stable throughout the storage period, with minor variations. The control sample had an initial aw of 0.824, which decreased to 0.816 by day 9. The experimental samples exhibited similar trends, with aw values ranging from 0.825 to 0.824 over the same period. The consistent aw values suggest that the addition of purslane powder does not significantly alter the water activity of the sausages, which is important for maintaining microbial stability.

The results indicate that the addition of purslane powder to organic sausages has a positive effect on moisture retention without significantly altering the pH and water activity. The higher moisture content in the experimental samples can contribute to improved sensory properties such as texture and juiciness. The stable pH and water activity values suggest that the addition of purslane powder does not compromise the microbial stability of the sausages.

Therefore, the application of purslane powder in organic sausages resulted in the improvement of certain quality parameters, such as moisture content and maintenance of water activity, which can contribute to extending the product's shelf life. The impact on pH indicates that purslane may play a role in regulating the acidity of the product. Overall, the use of purslane as an additive in organic sausages has a positive effect, but further research is necessary to optimize its concentration and evaluate its long-term impact on the microbiological stability and organoleptic properties of the product.

In this context, we conducted a sensory analysis of the experimental sausage samples (fig.1).

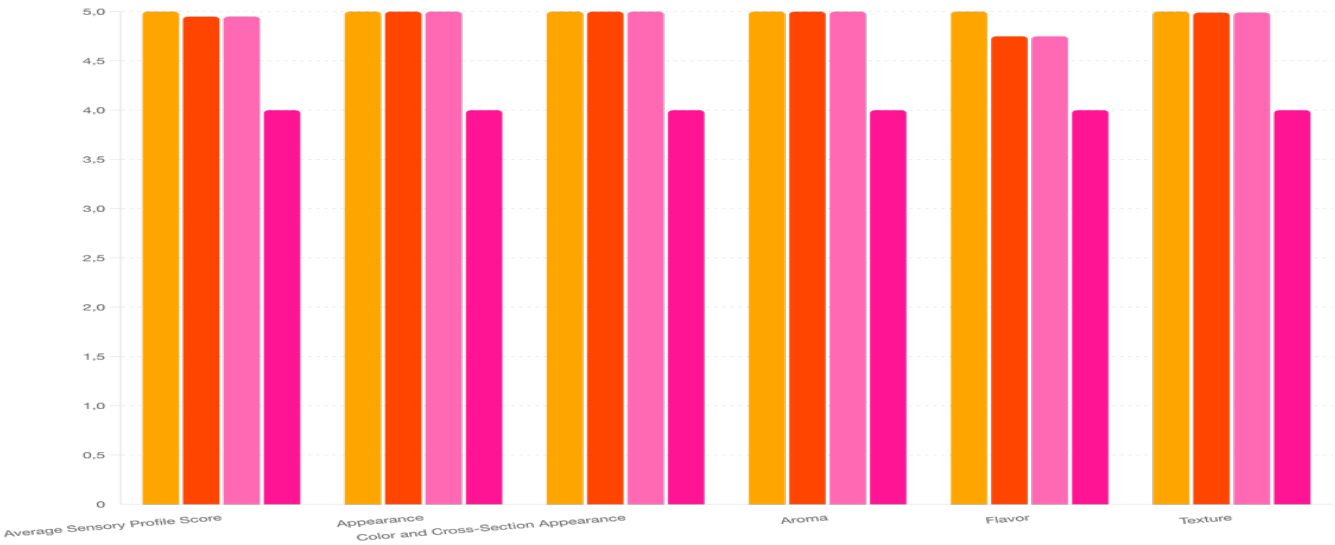

Figure 1 - Sensory analysis of control and experimental sausage samples with added purslane

The control sausage sample received the highest scores across all parameters (5.00). Samples with 0.8% and 1.2% purslane powder also received high scores, with negligible differences between them: the average sensory profile score was 4.95 for both samples. According to the results of the sensory analysis presented in the chart, the experimental samples 1 and 2 showed no significant differences from the control in terms of appearance, color, aroma, and flavor, receiving scores of 5.00, 5.00, 5.00, and 4.75, respectively. The texture was slightly lower (4.99) but still at a high level. The sample with 1.4% purslane showed a significant deterioration in all sensory characteristics, including the average score (4.00), appearance (4.00), color (4.00), aroma (4.00), flavor (4.00), and texture (4.00). These changes are associated with the emergence of a bitter taste and a greenish tint in the sausage, significantly affecting its appearance. Given the minimal differences between the samples with 0.8%

and 1.2% purslane, we decided to use experiment 2 with a concentration of 1.2% as the primary experiment, as it ensures high sensory scores without significant changes and provides the best physicochemical properties described above. Thus, adding 1.2% purslane to sausages maintains their quality and improves functional characteristics.

Microbiological safety and food quality are key aspects determining their suitability for consumption. One of the important indicators used to assess the microbiological quality of food products, including sausages, is the total viable count (TVC). This indicator allows for evaluating the total number of microorganisms capable of growing and forming colonies under aerobic and facultative anaerobic conditions at moderate temperatures. In the context of growing demand for organic and natural products, the use of natural additives to improve microbiological stability and extend the shelf life of food products is becoming increasingly relevant. Purslane powder (Portulaca oleracea) is known for its antioxidant and antimicrobial properties, making it a promising additive for sausages. This study will help determine the optimal concentration of purslane powder to achieve the best microbiological indicators without compromising the organoleptic properties of the product (Table 2).

Table 2 - Study of total viable count (TVC) in experimental sausage samples

Parameter	Days	Control	Experiment 1 (0.8% purslane)	Experiment 2 (1.2% purslane)	Experiment 3 (1.4% purslane)
TVC, CFU/g	1	$1{,}39*10^2$	$1{,}31*10^2$	$1{,}11*10^2$	$1{,}27*10^2$
	4	$1{,}27*10^3$	$1{,}47*10^2$	$1{,}03*10^2$	$1{,}01*10^2$
	9	$1{,}43*10^4$	$1{,}35*10^3$	$1{,}19*10^3$	$1{,}05*10^3$

On the first day, all samples showed similar initial levels of TVC, with slight differences. The lowest number of bacteria was recorded in the sample with 1.2% purslane (1.11×10^2 CFU/g). After 4 days, the number of bacteria significantly increased in the control sample (1.27×10^3 CFU/g). Samples with the addition of purslane demonstrated much lower bacterial growth. The sample with 1.4% purslane showed the lowest number of bacteria (1.01×10^2 CFU/g), indicating a strong antimicrobial effect. After 9 days, the control sample showed a significant increase in bacteria (1.43×10^4 CFU/g), whereas the samples with purslane maintained lower TVC levels. The sample with 1.4% purslane again demonstrated the lowest number of bacteria (1.05×10^3 CFU/g). The addition of purslane powder to the sausages significantly reduces the number of viable bacteria compared to the control sample. The lowest number of bacteria was recorded in samples with 1.2% and 1.4% purslane, especially on days 4 and 9. Experiment 2 (1.2% purslane) was chosen as the primary one since it provides a significant reduction in bacterial load without noticeable deterioration in the sensory characteristics of the product. In contrast, Experiment 3 (1.4% purslane) imparted a bitter taste and a greenish tint to the sausage, negatively affecting its appearance and flavor.

Conclusion. This study demonstrated that adding purslane powder (Portulaca oleracea) to organic sausages significantly improved their quality and shelf life. The experimental samples with purslane retained higher moisture levels and exhibited stable pH values, indicating enhanced product stability. Water activity remained consistent, ensuring microbiological safety. The total viable count (TVC) was significantly lower in samples with purslane, especially at 1.2% and 1.4% concentrations, compared to the control. Sensory analysis revealed that the sample with 1.2% purslane had high scores similar to the control, while 1.4% purslane negatively impacted flavor and appearance. Organic beef provided a high-quality protein source without synthetic additives, aligning with consumer demand for healthier products. Purslane powder, with its antioxidant and antimicrobial properties, proved to be an effective natural additive. The use of 1.2% purslane is recommended, offering a balance

between improved quality and sensory attributes. This natural approach supports the production of high-quality, organic sausages without synthetic preservatives.

Gratitude, conflict of interest (financing). This research is funded by the Ministry of Science and Higher Education of the Republic of Kazakhstan (BR21882327)

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