Dzhumazhanova M.M., Zhumadilova G.A. (2017) Inkapsulirovanie biologicheski aktivnyh dobavok i ih ispol'zovanie pri proizvodstve pishhevyh produktov [Encapsulation of biologically active additives and their use in food production]: monograph. – RSE on PCV Shakarim State University of Semey. – Almaty, – 218s. (In Russian)

12. "Medical Capsule Production Equipment" https://studopedia.ru/8_131209_oborudovanie-proizvodstva-meditsinskih-kapsul.html// (accessed 20.05.2023). (In Russian)

13. "Droplet Chart/Selection Guide", Virginia Cooperative Extension, publication 442-031 (BSE-263P); https://www.pubs.ext.vt.edu/442/442-031/442-031.html (accessed 05.01.2023)

14. "Fine Tuning a Sprayer with "Ounce" Calibration Method", Virginia Cooperative Extension. http://pubs.ext.vt.edu/442/442-453/442-453.html (accessed 18.12.2023)

15. Encapsulation and controlled release technologies in food systems. / 1-е изд. – под. ред. J. M. Lakkis. – Ames, Iowa: Blackwell. – 2007. – 239 P.

16. Kashima, K. Selective diffusion of glucose, maltose, and raffinose through calcium alginate membranes characterized by a mass fraction of guluronate / K. Kashima, M. Imai // Food and Bioproducts Processing. – 2017. - V. 102. – p. 213-221.

17. Podkorytova, A. V. (2001) Lechebno-profilakticheskie produkty i biologicheski aktivnye dobavki iz buryh vodoroslej [Therapeutic and prophylactic products and biologically active additives from brown algae] / A.V. Podkorytova, N. M. Aminina, V. M. Sokolova. // Fisheries. - No. 1 - pp. 51-52. (In Russian)

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EFFECT OF BLUE CORN GERM LEVELS ON QUALITY CHARACTERISTICS OF REDUCED-FAT SAUSAGES

M. KORZENIOWSKA

(Wroclaw University of Environmental and Life Sciences, 50-375 Wrocław, Poland, 25 Norwida St.)
Corresponding author e-mail: malgorzata.korzeniowska@upwr.edu.pl

The impact of reducing pork fat levels from 21% to 5% with varying concentrations of blue corn germ (2%, 3.5%, 5%, 8.5%, 13.5%, and 18.5%) on the physicochemical and textural properties of low-fat frankfurters was investigated. Decreased fat content correlated with reduced cooking loss, moisture content, and total lightness, redness, and yellowness of the sausages. Conversely, increased firmness and chewiness were observed. Frankfurters containing higher levels of blue corn germ exhibited enhanced firmness and chewiness compared to those with lower levels. Analysis of frankfurters with different fat and blue corn germ levels revealed an increase in hardness until the 8th day of storage, followed by a decrease by the 14th day. Optimal results were observed in samples containing 20% pork fat and 5% blue corn germ. However, excessive blue corn germ inclusion did not yield positive effects.

Keywords: Sausage, plant additive, blue corn, corn germ, antioxidant.

МАЙЛЫҒЫ ТӨМЕН ШҰЖЫҚТАРДЫҢ САПАЛЫҚ СИПАТТАМАСЫНА КӨК ЖҮГЕРІ ҰРЫҒЫНЫҢ ДЕҢГЕЙІНІҢ ӘСЕРІ

М. КОРЖЕНИОВСКА

(Вроцлав қоршаған орта мен өмір ғылымдары университеті, Польша, 50-375 Вроцлав, Норвида көш. 25)
Автор-корреспонденттің электрондық поштасы: malgorzata.korzeniowska@upwr.edu.pl

Көк жүгері ұрығының әртүрлі концентрациясы (2 %, 3,5 %, 5 %, 8,5 %, 13,5 % және 18,5%) мен шошқа майының 21%-дан 5%-ға дейін концентрациясының төмендеуі төмен майлы шұжықтардың физика-химиялық және текстуралық қасиеттеріне әсері зерттелді. Майдың азаюы пісіру шығындарының, ылғалдың, жалпы түстің ашықтығының, қызарудың және шұжықтардың сарғыштығының төмендеуімен байланысты болды. Ал керісінше, серпімділік пен шайнауға ыңғайлылықтың жоғарылауы байқалды. Көк жүгері ұрығының көп мөлшері бар майлығы төмен шұжықтар көк жүгері ұрығының аз мөлшерімен салыстырғанда қаттылық пен шайнауға ыңғайлылық қасиетінің жоғарылауымен

ерекшеленді. Әр түрлі майлы және көк жүгері ұрықтары бар майлығы төмен шұжықтарды талдау қаттылықтың 8-ші сақтау күніне дейін жоғарылағанын, содан кейін 14-ші күнге дейін төмендегенін көрсетті. Оңтайлы нәтижелер 20% шошқа майы мен 5% көк жүгері ұрығы бар үлгілерде байқалды. Алайда, көк жүгері ұрығын шамадан тыс қосу оң нәтиже бермеді.

Негізгі сөздер: шұжық, көкөніс қоспасы, көк жүгері, жүгері ұрығы, антиоксидант.

ВЛИЯНИЕ УРОВНЯ ЗАРОДЫШЕЙ СИНЕЙ КУКУРУЗЫ НА КАЧЕСТВЕННЫЕ ХАРАКТЕРИСТИКИ КОЛБАС С ПОНИЖЕННЫМ СОДЕРЖАНИЕМ ЖИРА

М. КОРЖЕНИОВСКА

(Вроцлавский Университет наук об окружающей среде и жизни,
Польша, 50-375 Вроцлав, ул Норвида 25)
Электронная почта автора-корреспондента: malgorzata.korzeniowska@upwr.edu.pl

Исследовалось влияние снижения содержания свиного жира с 21 % до 5 % при различной концентрации зародышей синей кукурузы (2 %, 3,5 %, 5 %, 8,5 %, 13,5 % и 18,5 %) на физико-химические и текстурные свойства низкожирных сосисок. Снижение содержания жира коррелировало с уменьшением потерь при варке, уменьшением содержания влаги, общей светлоты, красноты и желтизны колбас. Напротив, наблюдалось увеличение упругости и прожевываемости. Низкожирные сосиски, содержащие большее количество зародышей синей кукурузы, отличались повышенной упругостью и прожевываемостью по сравнению с теми, в которых содержание зародышей синей кукурузы было меньшим. Анализ низкожирных сосисок с различным содержанием жира и зародышей синей кукурузы показал увеличение твердости до 8-го дня хранения, а затем снижение к 14-му дню. Оптимальные результаты наблюдались в образцах, содержащих 20% свиного жира и 5% зародышей синей кукурузы. Однако чрезмерное включение зародышей кукурузы не дало положительного эффекта.

Ключевые слова: колбаса, растительная добавка, синяя кукуруза, зародыш кукурузы, антиоксидант.

Introduction

Zea mays L. corn is a versatile species. The color of corn grain depends on the content of pigments, which are found in the seed coat and aleurone layer.

Carotenoids give the corn grain a yellow or white color, and lutein and zeaxanthin are the main xanthophylls found in varieties with such coloration due to the presence of anthocyanins (up to 16.4 mg of anthocyanins/g). The main pigment is 3-O-β-D cyanidin glucoside (C3G) - the so-called chrysanthemin (about 73%). Other identified anthocyanins in blue corn are: 3-O-β-D glucoside of pelargonidin, 3-O-p-D-glucoside of peonidin, cyanidin 3-O-β-D-6-malonyl-glucoside, 3-O-β-D-(6-malonyl-glucoside of pelargonidin, and 3-O-β-D-6-malonyl-glucoside of peonidin.

Blue corn has not yet found wider use on an industrial scale [1, 2]. Among food products made from blue corn and available on the market (mainly in Mexico, South America, and the USA), tortillas, chips, and chips-tortillas dominate [3, 4]. In addition, traditional Central American dishes - corn atole, tostada, tlacoyo, tamale, and gordita - are made from it on a small scale [3, 5, 6, 7].

Many research results indicate a higher health-promoting value of products prepared on the basis of blue corn compared to other varieties, due to the high content of phenols, flavonoids and ferulic acid [8, 9]. Blue corn's starch has a higher protein content compared to white corn [10]. Bódi et al. [11] point to the high iron content of blue corn grain (even more than 40 mg/kg). Dickerson [5] notes the higher zinc content compared to yellow dent corn. New hybrid varieties are characterized by higher magnesium, potassium, manganese, and zinc contents compared to local lines [12], and some of them also have higher antioxidant potential [13].

In an era of increasing importance in the dietetics of functional foods, there has been increased interest in the phytochemical properties of the bioactive substances contained in blue corn and the potential for their wider use in the food industry [14-17]. The increase in the importance of blue corn observed in recent years is primarily related to the prospect of making functional foods from it that combine high nutritional value and health-promoting properties due to the presence of valuable amino acids, antioxidants, and micronutrients with taste [18].

Domestically grown blue corn grain may prove to be an interesting raw material due to its rich source of carbohydrates and bioactive substances - anthocyanins and flavanols, components with antiradical and antioxidant activity. By-products generated during the preparation of corn for brewing - germ removal - may be the subject of research. Germ flour has an intense color, starch content of about 34 to 39%, protein - about 10% and fat - about 12-15%.

This study aims to show the impact of the use of blue corn germ in a kind of frankfurter sausages. The choice of sausage can be explained by the fact that sausages had been already produced with an incorporation of yellow corn germ proteins [19]. This incorporation improves the stability and strength of emulsion due to the good water and fat binding capacities of these proteins [20]. Therefore, these capacities enable to obtain a better yield of production when corn germ proteins are added to the sausage [20]. All of these results can improve the texture of the final product and can allow sausage producers to have less waste in their production. Even if these results are obtained with yellow corn germ proteins, we can be sure that blue corn germ proteins have similar textural properties. Another study showed blue corn germ contains more proteins than yellow corn germ [21], so using blue corn germ can be a good thing for sausage texture. But the proportion of blue corn germs has to be enough to obtain good textural properties and not more to keep the taste of meat and not obtain an intense blue colour. This colour is due to the presence of anthocyanins [21]. Using blue corn germs in sausages can also improve the colour of these products. For the following study, non-defatted blue corn germ was used because the protein extraction and defatting process entail additional expenses and time for sausage producers. That is why several compositions were tried for experiments to determine what proportion of blue corn germs is the best for the organoleptic properties of sausages and their stabilities during storage.

Materials and research methods

Sausage formulation

Frankfurters were made with a blue corn germ content of 2%, 3.5%, and 5%. They have also been tested to decrease the amount of pork fat because blue corn germs already contain lipids. Indeed, too much lipid content could lead to greater oxidation of lipids (especially those of corn germs) [1] and lead to an unpleasant flavor. Thus, sausages having a pork fat content of 20%, 15%, 10% and 5% were prepared (Figure 1). Pork fat was offset by blue corn germ. Each frankfurter has a weight of 50 g and the different formulations are described in Table 1.

Table 1. Frankfurter formulations with various fat and corn germ levels (%)

Ingredients	Control	Treatments						
		2 % blue corn germ	3,5 % blue corn germ	5 % blue corn germ	20 % fat	15 % fat	10 % fat	5 % fat
lean pork	51	50	49	48	50	50	50	50
pork fat	21	20	21	21	20	15	10	5
ice	25	25	25	25	25	25	25	25
salt	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
blue corn germ	0	2	3,5	5	3,5	8,5	13,5	18,5

Figure 1. Frankfurters with various blue corn germ and fat levels

Physical-Chemical analysis

Cooking loss was determined following the method outlined by the Association of Official Analytical Chemists (AOAC) [22]. Frankfurter samples were cooked using the standardized method to ensure consistency across experiments. Peroxide value was determined using the method outlined by AOCS [23]. Thiobarbituric acid

reactive substances analysis (TBARS) was conducted following the method described by Botsoglou et al. [24]. The sample extracts were reacted with thiobarbituric acid and absorbance was measured spectrophotometrically. All determinations were performed in duplicate**.**

Instrumental analysis

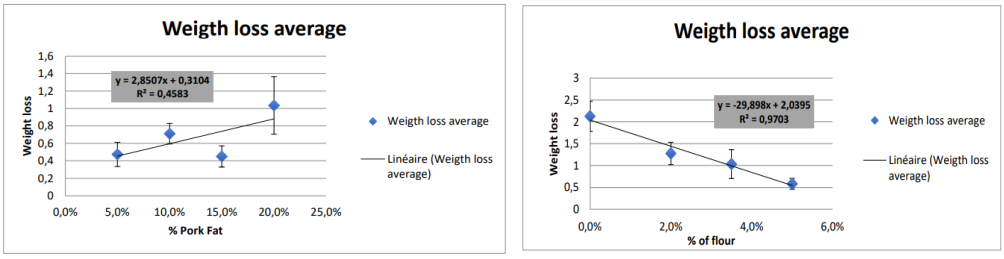
Texture profile analysis (TPA) was performed following procedures outlined by Bourne [25]. Samples were subjected to compression tests using a texture analyzer to assess parameters such as hardness, cohesiveness, springiness, and chewiness. Frankfurter samples were analyzed using a colorimeter to determine L* (lightness), a* (redness to greenness), and b* (yellowness to blueness) values, providing insights into the visual appearance of the products.

Sensory Evaluation

Sensory evaluation was conducted following standardized protocols described by Meilgaard et al. [26]. 10 trained panelists of the Department 'Functional food products development' evaluated the organoleptic properties of the frankfurter samples, including taste, aroma, appearance, and overall acceptability.

Results and discussion

The addition of blue corn germ has been found to significantly reduce the loss of cooking mass, resulting in a more efficient production yield. This is attributed to the functional properties of the proteins present in the germ. Furthermore, the sensory and textural attributes of the frankfurter sausages were positively impacted by the addition of blue corn germ, with improved firmness and chewiness noted in sausages formulated with higher levels of blue corn germ.



a) b)

Figure 2. Effects of cooking loss frankfurters formulated with various fat and blue corn germ levels

This loss reduction is 75% when a blue corn germ content is 5%. Thus, it can be said that the functional properties of the proteins of the blue corn germ have allowed a better yield of production. The moisture of the samples (Figure 3) is close between each sample and does not exceed more than 3%. But control frankfurter was the wettest. Thus, if the use of blue corn germ reduces the water content of the sample, the losses of mass related to the cooking of these samples are due to the loss of fat. These findings may be attributed to the phenomenon whereby FAX (soluble dietary fiber) retains free water within the meat product, consequently converting it into bound water [27].

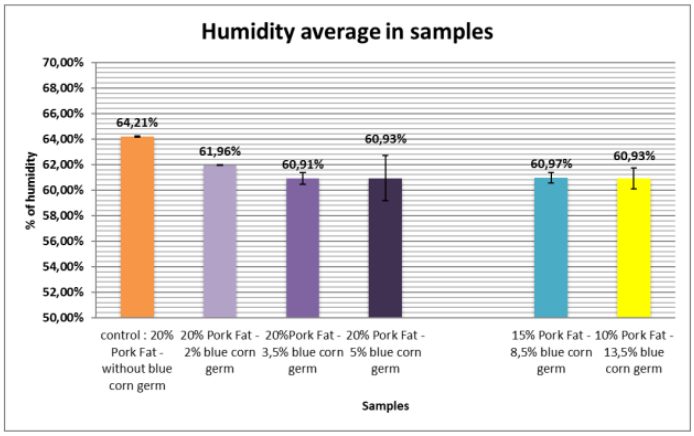


Figure 3. Humidity averages of frankfurters formulated with various fat and blue corn germ levels

There are observable changes in color parameters over time for all formulations, with variations in L*, a*, and b* values from 1 day to 14 days (Table 2). All frankfurter samples containing blue corn germ showed a significantly lower L* value than the control, indicating that

the samples were slightly darker. The a* and b* values of all test samples were higher than those of the control, which means that the samples were more reddish and less yellow than the phosphate-containing control. The L* values for the control group range from approximately 74.8 to 75.4 across the days of storage points, indicating relatively stable lightness levels. It was revealed that the L value decreased by adding chickpea flour [28]. The a* values increased from 1 day to 14 days of storage, suggesting a shift towards redness. The b* values decrease, indicating a shift towards yellowness. Formulations with blue corn germ: adding blue corn germ to the formulations appears to influence the color parameters compared to the control. For example, in the "20% pork fat - 2% blue corn germ" group, there's a slight decrease in L* values and a* values compared to the control, indicating slightly darker and less red frankfurters. However, the b* values remain relatively consistent. Impact of pork fat and blue corn germ content: variations in pork fat content (ranging from 5% to 20%) and blue corn germ content (ranging from 2% to 18.5%) also affect the color parameters. Generally, higher pork fat content tends to result in higher L* values and lower a* values, indicating lighter and less red sausages. Higher blue corn germ content appears to slightly decrease L* values and increase a* values, indicating darker and slightly redder frankfurter. Choi et al. investigated the effects of reducing pork fat levels from 30% to 20%, 155, and 10% by partially substituting pork fat with a makgeolli lees fiber in raw meat batters and frankfurters [29].

Table 2. Colour parameters (L∗, a∗, b∗ values) of frankfurters formulated with various fat and blue corn germ levels

Samples	L*			a*			b*		
	1 day	7 days	14 days	1 day	7 days	14 days	1 day	7 days	14 days
control: 20% pork fat-without blue corn germ	74,798	75,364	75,088	5,108	6,372	7,266	8,084	7,984	7,994
20% pork fat-2% blue corn germ	73,9	73,672	74,934	5,512	5,952	6,774	7,298	6,944	6,648
20% pork fat-3,5% blue corn germ	75,13	72,614	73,494	5,58	5,592	6,026	7,29	6,67	6,45
20% pork fat-5% blue corn germ	70,72	73,11	73,244	4,28	5,114	5,702	5,42	3,926	4,58
5% pork fat-18,5% blue corn germ	61,56	63,202	67,036	4,14	5,48	4,646	2,42	2,528	2,894
10% pork fat-13,5% blue corn germ	67,98	68,05	73,0	4,19	4,798	6,148	5,2	3,926	5,126
15% pork fat-8,5% blue corn germ	72,4	71,106	64,888	4,29	4,434	5,896	6,49	5,194	3,928

The evolution of the peroxide values (Figure 4) was generally the same for each sample. However, for the first day, the value of the control was the biggest indicating that this sample was the most oxidized. Thus, it is noticed that there is no more oxidation with the blue corn germ. The decreased peroxide value with the increased addition of blue corn germ might be due to the high content of phenols, flavonoids, and ferulic acid [8, 9]. In other research on skinless beef sausages, the peroxide value was slightly decreased ($p<0.05$) with the addition of wheat germ flour [30].

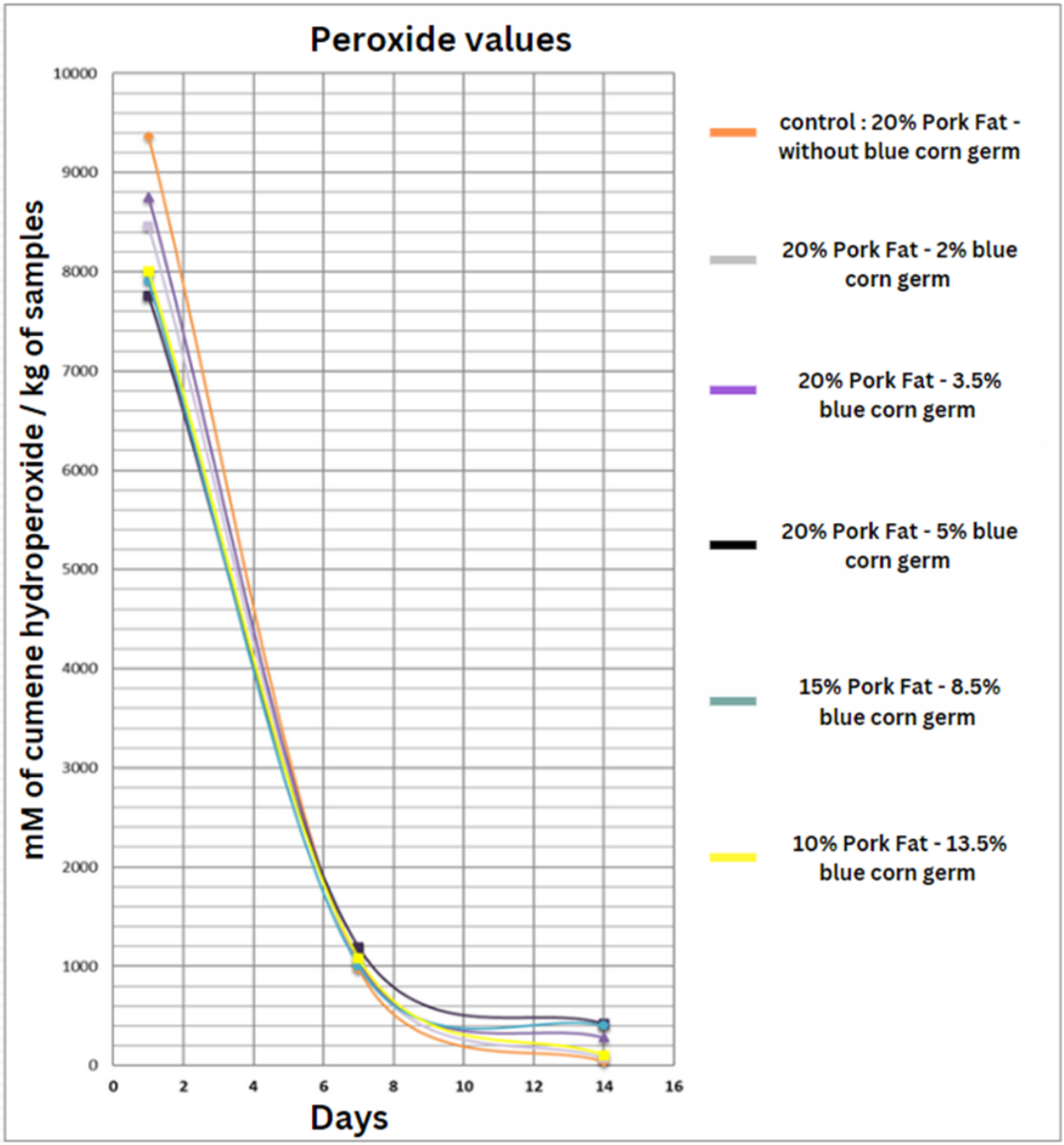


Figure 4. Peroxide values of frankfurters formulated with various fat and corn germ levels

TBARS values were influenced by both the concentration of added blue corn germ and storage conditions (Figure 5). From the outset of storage, TBARS values were lower in the frankfurters formulated with various fat and blue corn germ levels than in the control. The TBARS value of the formulation with 10% pork fat and 13.5% blue corn germ decreased on the 7th day of storage and slightly increased till the 14th day of storage. It has been suggested that the reduction in TBARS values might be attributed to the emergence of malonaldehyde as an intermediary compound. Within a specified timeframe, the pace of malonaldehyde generation surpassed that of the compound's depletion; subsequently, a reversal occurred wherein the rate of disappearance surpassed the rate of formation. Consequently, this led to a decline in TBARS values [31].

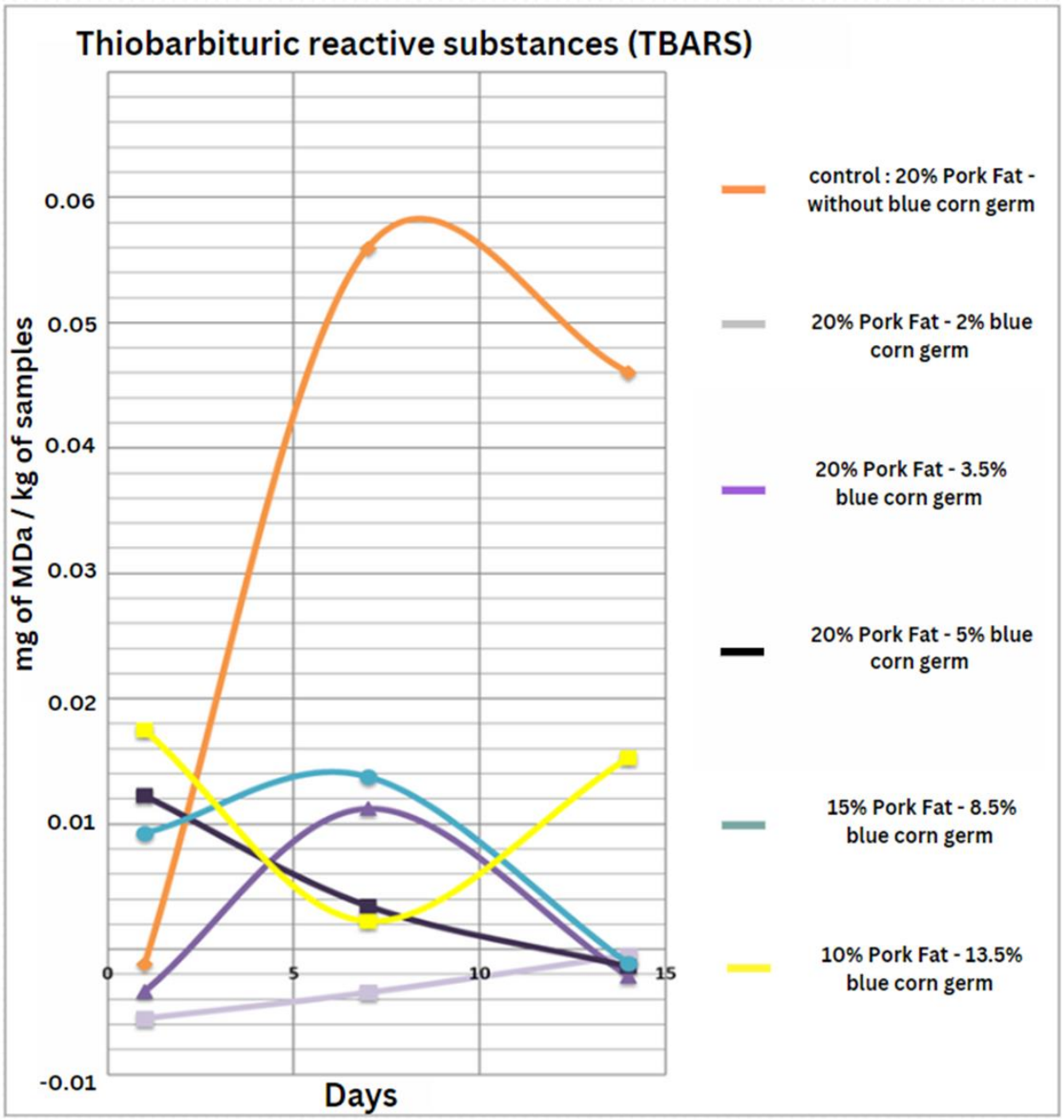


Figure 5. TBARS values of frankfurters formulated with various fat and corn germ levels

Data presented in Figure 6 shows the sensory properties (aroma, color, taste, texture, juiciness, tenderness, cohesiveness, homogeneity, and overall acceptability) of control and frankfurters formulated with various fat and corn germ levels. It also appears that the presence of blue corn germ gives a more attractive general appearance to sausages compared to the control. From the results, it was observed that the addition of blue corn germ enhanced the sensory characteristics at concentrations of 2%, 3.5%, and 5%. The best scores for sensory properties were recorded at 5.0, 5.01, and 5.0 in overall acceptability compared to the control sausage, which scored 4.0. These results show that the blue corn germ contained high amounts of total phenolic compounds and total flavonoids may improve the acceptability of frankfurters.

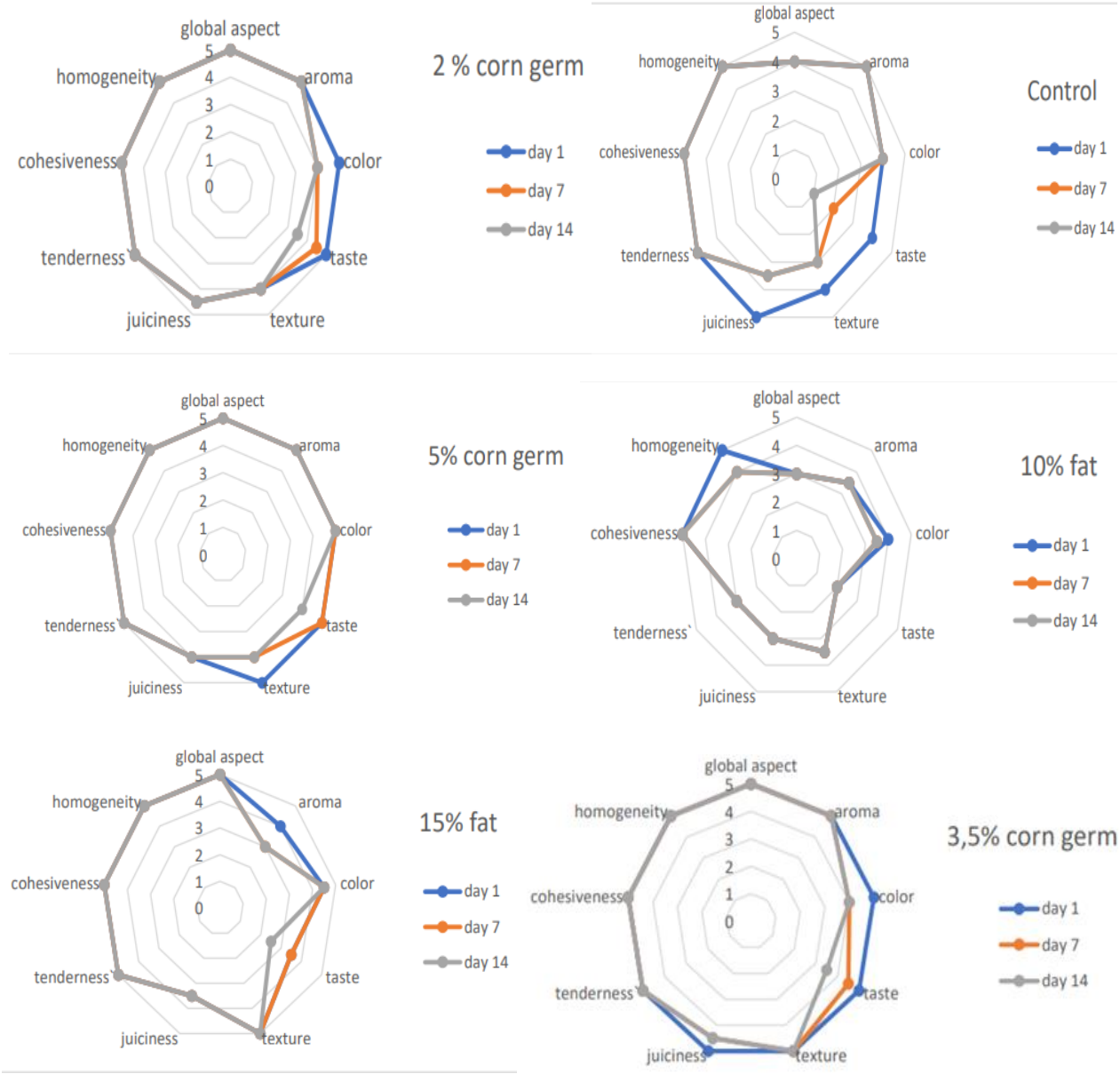
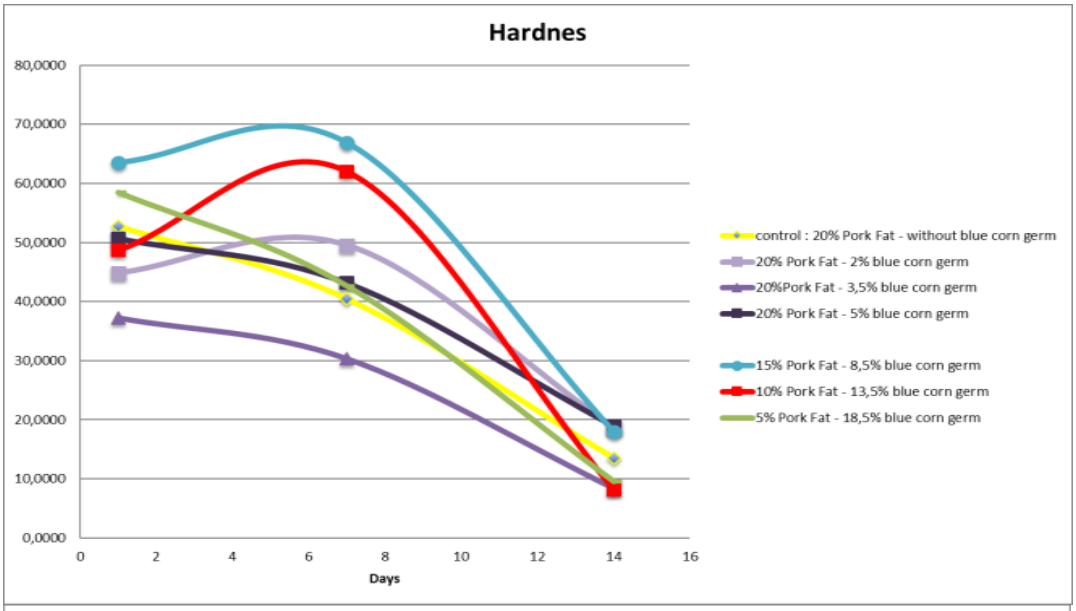


Figure 6. Sensory evaluation of frankfurters formulated with various fat and blue corn germ levels

The TPA attributes of frankfurters formulated with various fat and blue corn germ levels (Figure 7) indicate that the hardness slightly increased for all treatments and the control without any additive until the 8th day of storage, then significantly decreased by the 14th day. Texture profile analysis was conducted using a texture analyzer to evaluate the textural properties of the frankfurter sausages. The results revealed that the incorporation of blue corn germ led to significant improvements in the texture of the sausages. Notably, sausages formulated with higher levels of corn germ exhibited increased firmness and chewiness compared to those with lower levels of corn germ. Research on TPA attributes of frankfurters formulated with various fat and corn germ levels shows that the hardness of all treatments and control without any additives increased slightly until the 8th day of storage, then significantly decreased by the 14th day. This suggests that the addition of blue corn germ not only enhances the initial texture of the sausages but also contributes to improved texture stability over time.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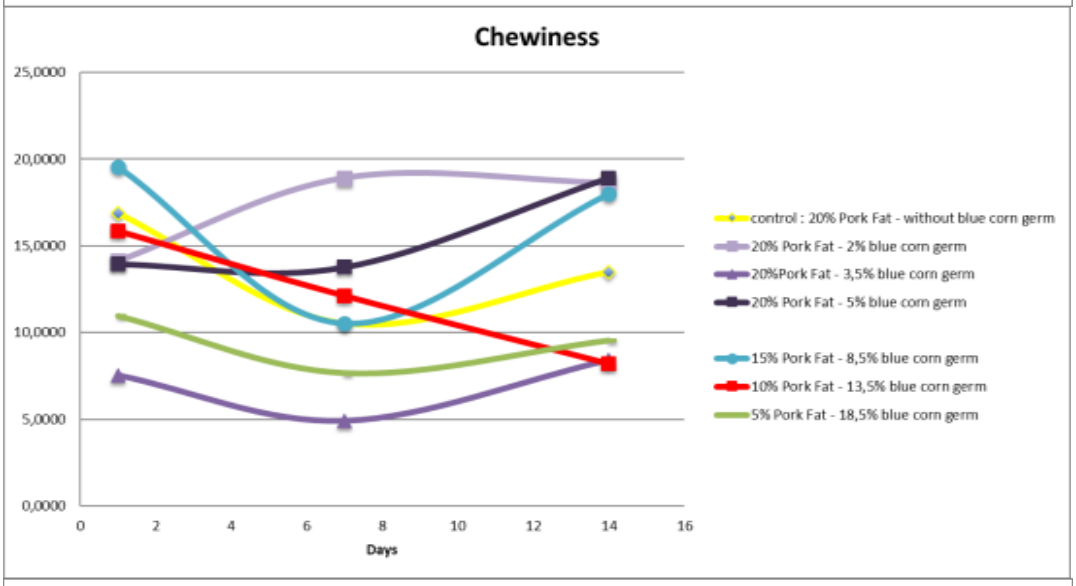
5% Pork Fat - 18,5% blue corn germ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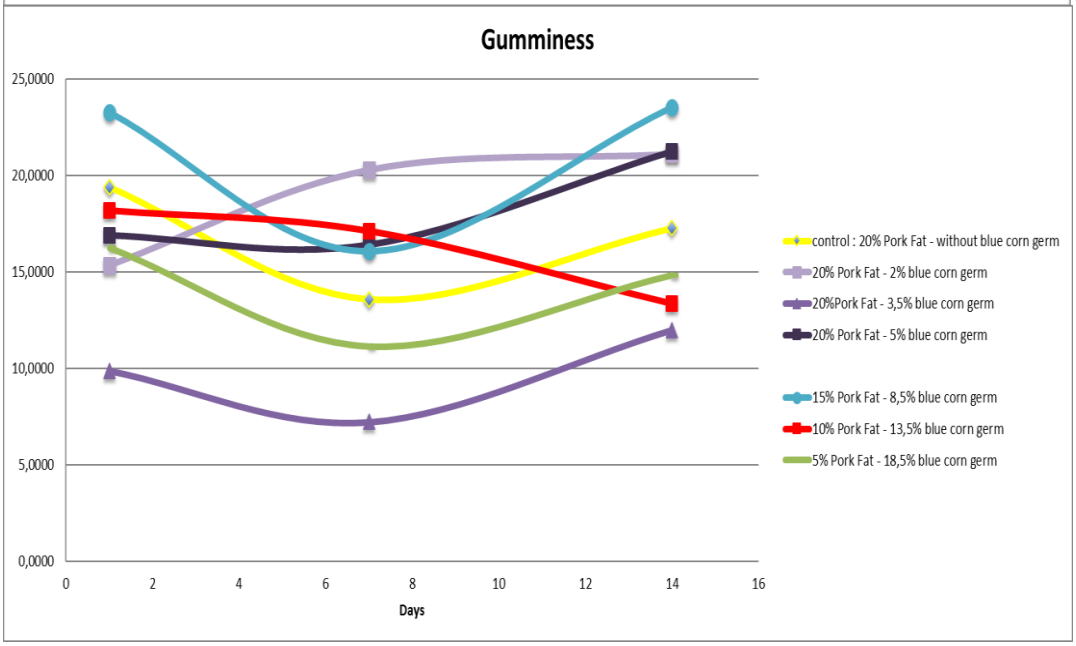
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10% Pork Fat - 13,5% blue corn germ
5% Pork Fat - 18,5% blue corn germ

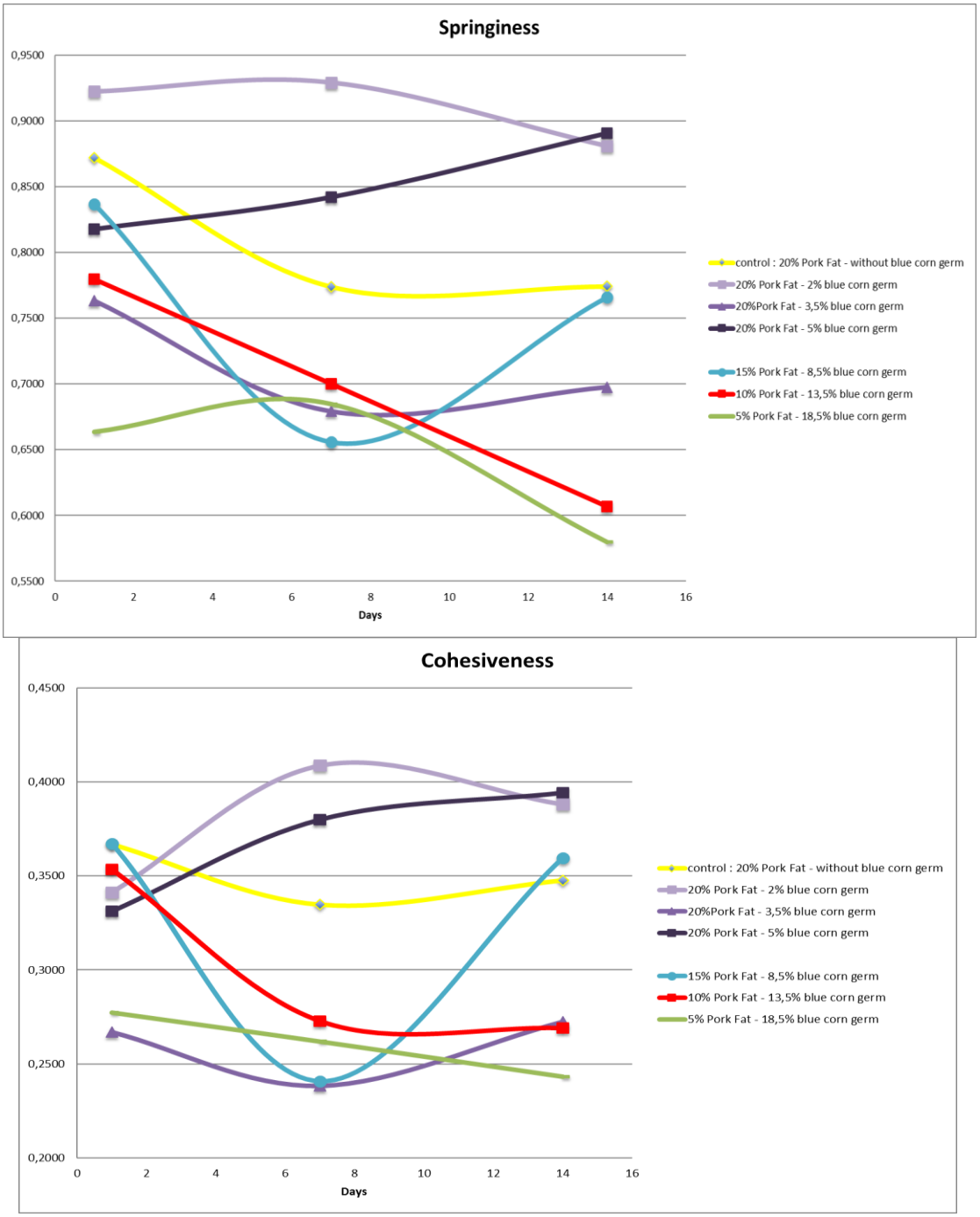

Figure 7. TPA attributes of frankfurters formulated with various fat and blue corn germ levels

Conclusion

Low-fat frankfurters can be manufactured by incorporating a combination of blue corn germ, resulting in a product with favorable attributes. The formulation of frankfurters and storage conditions influence various product characteristics, including cooking loss, color, peroxide and TBARS values, TPA attributes, and sensory properties, all of which were evaluated in this study. Optimal results were observed in samples containing 20% pork fat and 5% blue corn germ. However, excessive blue corn germ inclusion did not yield positive effects. In addition, these results suggest that this can be a suitable strategy for the production of low-fat frankfurters as a potential functional food.

REFERENCES

1. Rosa-Millán J., Agama-Acevedo E., Jimenez-Aparicio A. R., Bello-Pérez L A. 2010. Starch characterization of different blue maize varieties. Starch 62: 549-557.

2. Petroni K., Pilu R., Tonelli Ch. 2014. Anthocyanins in corn: a wealth of genes for human health. Planta 240: 901–911.

3. Cortés-Gómez A., Pérez J., Orea A., Martinez E. 2006. Photoacoustic analysis of blue corn pigments in nixtamalized flours. International Journal of Thermophysics 26(4): 1274-1280.

4. Sánchez-Madrigal M.Á., Quintero-Ramos A., Meléndez-Pizarro C.O., Ruiz-Gutiérrez M.G., Camacho-Dávila A., Martínez-Bustos F., Torres-Chávez P.I., Ramírez-Wong B. 2015. Effect of different calcium sources on the bioactive compounds stability of extruded and nixtamalized blue maize flours. Journal of Food Science and Technology 52(5): 2701-2710.

5. Dickerson W. 2003. Nutritional analysis of New Mexico Blue Corn and Dent Corn Kernels. Las Cruces: Cooperative extension service, college of agriculture and home economics. New Mexico State University.

6. Salinas-Moreno Y., Pérez-Alonso J. J., Váz-quez-Carrillo G., Aragón-Cuevas F., Velázquez-Cardelas G. A. 2012. Antocianinas y actividad antioxidante en maíces (Zea mays L.) De las razas Chalqueño, Elotes cónicos y Bolita. Agrociencia.46: 693-706.

7. Jiménez-Pérez C., Ramírez-Romero G., Morán-Bañuelos S.H. 2015. Instant flour from red and blue nixtamalized maize: production and textural properties of tortilla. Journal of Food Processing & Preservation 39(1): 38-46.

8. Zilic S., Serpen A., Akillioglu G., Gokmen V., Vancetovic J. 2012. Phenolic compounds, carotenoids, anthocyanins, and antioxidant capacity of colored maize (*Zea mays* L.) Kernels. Journal of Agricultural and Food Chemistry. 60(5): 1224-1231.

9. Mora-Rochin S., Gutiérrez-Uribe J. A, Serna-Saldivar S. O., Sánchez-Peña P., Reyes-Moreno C., Milán-Carrillo J. 2010. Phenolic content and antioxidant activity of tortillas produced from pigmented maize processed by conventional nixtamalization or extrusion cooking. Journal of Cereal Science. 52(3): 502-508.

10. Utrilla-Coello, R. G., E. Agama-Acevedo, A. P. Barba de la Rosa, J. L. Martínez-Salgado, S. L. Rodríguez-Ambriz, and L. A. Bello-Pérez, 2009. Blue maize: Morphology and starch syn-thase characterization of starch granule. Plant Foods Hum. Nutr. 64: 18-24

11. Bódi, Z., Pepo, P., Kovács, A., Szeles, E., & Győri, Z. (2008). Macro-and microelement contents of blue and red kernel corns. Cereal Research Communications, 36(1), 147-155.

12. Urias-Lugo, D. A., Heredia, J. B., Serna-Saldivar, S. O., Muy-Rangel, M. D., & Valdez-Torres, J. B. (2015). Total phenolics, total anthocyanins and antioxidant capacity of native and elite blue maize hybrids (Zea mays L.). CyTA-Journal of Food, 13(3), 336-339.

13. Urias-Peraldí, M., Gutiérrez-Uribe, J. A., Preciado-Ortiz, R. E., Cruz-Morales, A. S., Serna-Saldívar, S. O., & García-Lara, S. (2013). Nutraceutical profiles of improved blue maize (Zea mays) hybrids for subtropical regions. Field Crops Research, 141, 69-76.

14. Harrigan, G.G., et al. (2007). Impact of genetics and environment on nutritional and metabolite components of maize grain. J. Agri. Food Chem. 55, 6177–6185

15. Castañeda-Ovando, A., de Lourdes Pacheco-Hernández, M., Páez-Hernández, M. E., Rodríguez, J. A., & Galán-Vidal, C. A. (2009). Chemical studies of anthocyanins: A review. Food chemistry, 113(4), 859-871.

16. Camacho-Hernández, I. L., Zazueta-Morales, J. J., Gallegos-Infante, J. A., Aguilar-Palazuelos, E., Rocha-Guzmán, N. E., Navarro-Cortez, R. O., ... & Gómez-Aldapa, C. A. (2014). Effect of extrusion conditions on physicochemical characteristics and anthocyanin content of blue corn third-generation snacks. CyTA-Journal of Food, 12(4), 320-330.

17. Hernández-Martínez, V., Salinas-Moreno, Y., Ramírez-Díaz, J. L., Vázquez-Carrillo, G., Domínguez-López, A., & Ramírez-Romero, A. G. (2016). Color, phenolic composition and antioxidant activity of blue tortillas from Mexican maize races. CYTA-Journal of Food, 14(3), 473-481.

18. Pepó, P. (2014). New results of nutrient utilization and response of maize (Zea mays L.) hybrids. COLUMELLA–Journal of Agricultural and Environmental Sciences, 1(2), 87-93.

19. Comminuted meat products supplemented with corn germ protein [Internet]. [cited 2017Aug 30]. Available from:
http://www.google.com/patents/US4849244

20. Lin C s., Zayas J. Influence of Corn Germ Protein on Yield and Quality Characteristics of Comminuted Meat Products in a Model System. Journal of Food Science. 1987 May 1;52(3):545–8.

21. Somavat P, Li Q, de Mejia EG, Liu W, Singh V. Coproduct yield comparisons of purple, blue and yellow dent corn for various milling processes. Industrial Crops and Products. 2016 Sep 1;87:266–72.

22. Association of Official Analytical Chemists (AOAC). (1990). Official Methods of Analysis. AOAC International.

23. American Oil Chemists' Society (AOCS). (2017). Official Methods and Recommended Practices of the AOCS. AOCS Press.

24. Botsoglou, N. A., et al. (1994). Thiobarbituric acid reactive substances (TBARS) measurement: A review. Food Research International, 141, 110136.

25. Bourne, M. C. (1978). Food Texture and Viscosity: Concept and Measurement (2nd ed.). Academic Press.

26. Meilgaard, M. C., et al. (2016). Sensory Evaluation Techniques (5th ed.). CRC Press.

27. Herrera-Balandrano, D.D.; Baez-Gonzalez, J.G.; Carvajal-Millan, E.; Muy-Rangel, D.; Urias-Orona, V.; Martinez-Lopez, A.L.; Marquez-Escalante, J.A.; Heredia, J.B.; Beta, T.; Nino-Medina, G. Alkali-extracted feruloylated arabinoxylans from nixtamalized maize bran byproduct: A synonymous with soluble antioxidant dietary fiber. Waste Biomass Valori. 2018, 1–7.

28. J. Pereira, Z. Gh, and W. Zhang, “Effects of rice flour on emulsion stability, organoleptic characteristics and thermal rheology of emulsified sausage,” Journal of Food and Nutrition Research, vol. 4, pp. 216–222, 2016.

29. Choi, Y.S.; Kim, H.W.; Hwang, K.E.; Song, D.H.; Choi, J.H.; Lee, M.E.; Chung, H.J.; Kim, C.J. Physicochemical properties and sensory characteristics of reduced-fat Frankfurters with pork back fat replaced by dietary fiber extracted from makgeolli lees. Meat Sci. 2014, 96, 892–900

30. Elbakheet, S. I., Elgasim, E. A., & Algadi, M. Z. (2018). Utilization of wheat germ flour in the processing of beef sausage. *Adv Food Process Technol: AFPT-101. DOI, 10*.

31. M. Bhattacharya, M.A. Hanna, R.W. Mandigo. Lipid oxidation in ground-beef patties as affected by time-temperature and product packaging parameters. Journal of Food Science, 53 (3) (1988), pp. 714-717.

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APPLICATION AND SAFETY OF PECTIN SUBSTANCES FROM VEGETABLE RAW MATERIALS IN BREAD PRODUCTION

*[1]A.A. ZHELDYBAEVA**, *[1]S.T. AZIMOVA*, *[2]S.E. AMAN*,
[2] A. TEMIRBEKKYZY, *[2] Z.T. SARSENBAYEVA*

([1]Almaty Technological University, 050012, Kazakhstan, Almaty, Tole bi str., 100
[2] JSC “Kyzylorna Korkyt Ata University”, 120014,
Kyzylorda, Aiteke bi str., 29A)
Corresponding author e-mail: runia_@mail.ru*

Currently, pectin substances and their compounds are often used in cooking as an anionic surfactant. In the technology of food preparation, such properties of pectin substances as swelling, thickening, gel-forming, crystal-forming, water-absorbing ability, and emulsifying ability are of great importance. Like any gel-forming fiber, pectin helps remove heavy metals from the body such as lead, mercury, cadmium, etc. MCP may be better suited for these purposes, as it has been used in four clinical studies of heavy metal detoxification. Considering the accumulation of radioactive elements, heavy metal salts and pesticides in the environment and the human body, Jerusalem artichoke, which is rich in pectin substances, carotene and dietary fiber, is of particular interest. It is also economically beneficial as it is a domestic raw material. The goal of scientific research is to obtain a new type of functional bread with the addition of vegetable pectin. In this article, it was determined that the addition of pectin to dough has an effect on biochemical, colloidal, as well as microbiological processes. It also affects the physicochemical and rheological properties and reduces the content of contaminants. The work investigated that when pectin substances are added to the dough, its initial acidity increases. Acidity varied 2.2-2.4. It was also noted that in the test sample the fermentation process was more active; the activity of the fermentation process was associated with the addition of sugar along with pectin. As a result of this work, in order to improve the quality of bread and extend shelf life, pectin from raw materials of plant origin was added, the properties of bread samples with Jerusalem artichoke pectin with high performance were studied, and their organoleptic, physicochemical and safety indicators were studied. It was revealed that pectin reduces the content of some toxic elements by up to 100%. Practical significance: the conducted studies showed that the obtained samples of functional bread can be recommended for introduction into production to expand the range of bakery products.

Keywords: pectin, modified citrus pectin (MCP), complexation, heavy metal salts, Jerusalem artichoke, properties of pectin, bread.