Original Research Article: full paper

(2022), «EUREKA: Life Sciences»
Number 6

EFFECTS OF TARO PASTE ON PHYSICOCHEMICAL PROPERTIES AND NUTRITIONAL COMPONENTS OF BRAN PORK SAUSAGE

Tanya Kryzhska✉
Department of Technology and Food Safety[1]
kryzhska@meta.ua

Fei Fei Shang
Department of Technology and Food Safety[1]

[1]*Sumy National Agrarian University*
160 Herasyma Kondratieva str., Sumy, Ukraine, 40000

✉**Corresponding author**

Abstract

The research of adding plant materials to sausage is more popular. Taro paste is the plant raw material obtained by mashing taro after cooking. It contains rich small granules of starch, dietary fiber, and sweetened drinks are widely added. The natural flavor and the quality of glutinous taro paste are its unique characteristics. In this study, different proportions of taro paste were added to the pork sausage containing bran instead of starch, and the substitution amount was 0 %, 20 %, 40 %, 60 %, 80 %, and 100 % respectively. It is expected to improve the tissue structure, sensory quality, and nutritional composition of the sausage. This study analyzed cooking loss, emulsion stability, color, texture characteristics, moisture, sensory changes, and nutrient composition. The results showed that compared with the control group, the cooking loss, water loss and fat loss decreased significantly, and the brightness (L* value) of sausage increases, the yellowness (b* value) shows an unstable fluctuation of decreasing and increasing, and the redness (a* value) has no obvious change; The hardness and viscosity of the sausages were significantly reduced, but the elasticity and resilience were not significantly altered; The relaxation time is shortened, and the internal semi bound moisture content is increased; Sensory evaluation results showed that all treatment groups achieved the best scores in terms of overall acceptable levels, especially for sausages with taro instead of 40 % starch; Protein, ash, water content and pH also gradually increased, while fat content decreased. By comprehensive comparison, the quality of the sausages is best when the amount of taro paste is 40 %.

Keywords: taro paste, bran pork sausage, nutritional components**,** TPA, physicochemical properties.

DOI: 10.21303/2504-5695.2022.002694

1. Introduction

As Chinese people's living standards have improved in recent years, the consumption of meat and meat products has also increased. China's meat consumption far exceeds that of the rest of the world. China is now the world's biggest meat consumer and largest meat producer.

Meat is a nutritious food that provides the body with a variety of essential nutrients. Sausage products are widely loved in China. However, because sausage is characterized by high levels of fat and cholesterol, long-term and excessive consumption can have some adverse effects on human health [1]. As a representative meat product, smoked and boiled sausages have long been favored because of the special flavor of the meat product and its small size, which makes it easy to carry and preserve. The fat content in traditional smoked and boiled sausages is generally about 10 % [2]. The high fat content is conducive to the formation of a good flavor in smoked and boiled sausages, improving the retention of moisture in sausages and making them more flavorful, juicy and delicate.

At present, research on fat replacement at home and abroad has not found any substance that can completely replace fat, most of which are added to food after being combined with several substances to partially replace fat. Starch is used in the processing of meat products. Starch can combine with protein in meat to form a special protein composite gel. This gel is superior to a single meat protein gel because this protein complex will produce gel starch during heating, which will improve the quality and sensory properties of sausage [3]. In the process of food production and processing, especially in meat products, an appropriate amount of denatured starch will be added as a fat substitute [4]. In the making of sausages, a moderate amount of modified starch is usually added to improve the water holding capacity of the sausages and give them good structural properties. In [5] it is found through experiments that, compared with meat products added with natural starch, after adding denatured starch to meat products, the tissue structure, water retention and taste of meat products have been improved, and the product quality has also been effectively improved.

In [6] it is found that potato starch was used as a fat substitute in emulsified sausage, and the addition of potato starch played a role in emulsification and thickening, and effectively improved the quality of sausage. In [7] studied the application of corn, cassava and potato modified starch in sausage products, and determined that the best type of modified starch is potato modified starch, with the addition amount of 15 %. In [8] it is found through experimental studies that sausages made with 10 percent modified starch from Harbin had the best viscosity and elasticity, moderate change and hardness, and better taste than those made without the modified starch.

Taro is a high quality vegetable with a high starch content. The flesh is fine, glutinous, and nourishing. It contains starch, coarse proteins, dietary fiber, vitamins, inorganic salts and other ingredients that are beneficial to human health. In addition, areca taro has a variety of functional health benefits, such as strengthening the spleen and stomach. Regular consumption of areca taro is good for the body [9, 10]. Areca taro is a green food rich in high-quality starch. If you want to strengthen the viscosity and water retention of meat products, it is possible to add an appropriate amount of Areca esculenta starch to the production and processing of meat products. Because the starch granules are very small and the surface is surrounded by many mucopolysaccharides, it is difficult to extract [11]. Therefore, in this study, different areca taro mash is used to replace starch to study the effect on the quality of bran sausage, which has important application value for the fat reducing effect of sausage and other meat products.

2. Materials and methods

1. Materials procurement. Pork, wheat bran, taro, potato starch, salt, five-spice powder, pepper, rice wine, swine casings, red yeast rice powder was bought from the local market at West city, Hezhou, China. Complex phosphate (Harsen Foods (Hongkong) Co., LTD, Shantou, China, Sodium pyrophosphate 60 %, sodium tripolyphosphate 39 %, sodium hexametaphosphate 1 %).

2. Instruments and equipment. Colorimeter(color difference meter CR-400, Shoufeng Instrument Technology Co., Ltd, Changzhou, China; calibrated with a white plate, L^*=+97.83, a^*=−0.43, b^*=+1.98). Texture profile analysis was measured at room temperature with a texture analyzer (TA.XT PLUS, Stable Micro System, UK). Water distribution analysis with low field nuclear magnetic resonance instrument, nuclear magnetic resonance imaging analyzer (NMI20, Shanghai Newmai Electronic Technology Co., Ltd, Shang Hai, China).

3. Processing of taro paste sausage. Chopped taro, steamed and mashed, wheat bran flour sifted (80 meshes), pork chops are ground into meat paste→adding ingredients according to the ingredient list (**Table 1**) →adding ice water and mixing→stir evenly→the casing is put into the sausage machine→the casing is knotted at one end→ Enema→air in a ventilated place until the skin is dry→put the chicken sausage in a water bath of about 80 °C for 30 min.

Table 1
Recipes of bran pork sausages with different taro paste

Ingredient (g)	0 %	20 %	40 %	60 %	80 %	100 %
Pig skin	400	400	400	400	400	400
Fat(pig)	100	100	100	100	100	100
Wheat bran	8.0	8.0	8.0	8.0	8.0	8.0
Potato starch	75	60	45	30	15	0
Taro paste	0	20	40	60	80	100
Ice water	100	95	90	85	80	75
Other ingredients	40	40	40	40	40	40

Note: Other ingredients include 7 g of salt, 1.5 g of complex phosphate, 4 g of complex spices, 1.5 g of pepper, 1 g of red yeast rice, 25 g of rice wine.

4. Physicochemical properties. Cooking loss and Emulsion stability of sausage. Refer to the method [12]. Weigh 35 g minced meat into a 50ml centrifuge tube and centrifuge (3000 rpm, 5 min) to remove air bubbles in the tube. Then, heat it in a water bath (75 °C, 30 min), cool the heated sample at room temperature for 1 hour, weigh it after cooling, and record its mass.

The calculation of cooking loss is shown in (1):

$$\text{Cooking loss}\left(\%\right)= =\left[\left(\begin{array}{l}\text{weight of raw meat batters }\left(\text{g}\right)-\\ -\text{weight of cooked meat batters }\left(\text{g}\right)\end{array}\right)/\text{weight of raw meat batters }\left(\text{g}\right)\right]\times 100. \quad (1)$$

Pour the liquid lost during cooking (centrifuge tube upside down for 40 minutes) into a glass dish. Moisture loss is the weight of the liquid lost by cooking and drying after heating at 105 °C for 16 hours, while fat loss is the mass of the sample remaining after the drying of the liquid lost by cooking [13, 14]. The calculation of water loss and fat loss is shown in (2), (3):

$$\text{Moisture loss}\left(\%\right)= =\left[\left(\begin{array}{l}\text{Weight of Cooking liquid}-\\ -\text{Remaining weight after heating}\end{array}\right)/\text{Weight of raw meat batter}\right]\times 100. \quad (2)$$

$$\text{Fat loss}(\%)=(\text{Remaining weight after heating}/\text{Weight of raw meat batter})\times 100. \quad (3)$$

Color. Place the sausages stored at 4°C at room temperature to equilibrate for 1 hour. Use the colorimeter and *O*/*D* test head to determine the brightness value (L^*), redness value (a^*) and yellowness value (b^*).

pH. Add 5 g of raw meat emulsion to 20 mL of distilled water, stir evenly, and let it stand at room temperature for 30 minutes, and measure the upper liquid with a pH meter. Cut 5 g of sausage into pieces and add 20 mL of distilled water. After homogenizing, let it stand at room temperature for 30 min, and measure the upper liquid with a PH meter.

Protein (AOAC Method 2011.04); Fat (AOAC Method 991.36); Ash (AOAC Method 920.153); Moisture (AOAC Method 950.46).

The chicken intestines stored at 4 °C were placed at room temperature to equilibrate the temperature, and the sample was cut into 40×20 mm (height×diameter) cylinders to determine the texture. The experiment uses the TPA puncture method to measure chicken sausages. The probe model is P/5. Set the measured parameters, 5 mm/s before the test rate, 1 mm/s test rate, 1 mm/s after the test rate, 50 %. The compression ratio, 5 g trigger force. The measurement indicators include hardness, elasticity, cohesiveness, chewiness, adhesiveness and recovery.

Moisture distribution. In order to determine the internal water dynamic distribution of raw minced meat and cooked sausage in different treatment groups, low field nuclear magnetic resonance technology [15] was used in this experiment. Wrap the raw minced meat into a spherical sample with a diameter of about 5 mm. Similarly, wrap the cooked sausage into a spherical sample with a diameter of 5 mm. Add meat balls to the bottom of the nuclear magnetic tube during the determination, and use the analysis application software to determine the sample relaxation time. The relaxation time data measured by the sample is inverted by the software (CONTIN) to obtain the corresponding signal strength and relaxation time. Then, use the imaging software of the system to conduct pseudo color processing on the picture.

Sensory evaluation. Invite 10 food majors with sensory evaluation experience to form an evaluation team. Cut off both ends of the heated sausage, cut the middle part into a 1cm-long cylinder, and distribute the chicken sausages of different experimental groups to the group members for evaluation. Mainly evaluate the color, hardness, flavor, viscosity and overall acceptability of bran chicken sausage. The scoring table is shown in **Table 2**.

Table 2
Sensory Evaluation Standard

Evaluation index	Evaluation score		
	1~3 Score	4~6 Score	7~9 Score
color	No appetite, poor color	Average appetite, normal color	Appetite, attractive color
Texture	The taste is rough and hard	The taste is slightly rough and hard	The taste is fine and elastic
Flavor	No sausage taste	Average sausage taste	Suitable sausage taste
Viscosity	Sticky teeth	Slightly sticky teeth	Non-sticky teeth
Overall acceptability	Not accept	Accept	Like

5. Data analysis. The measurement index is repeated 3 times, and the data results are all expressed as mean ± standard deviation ($\bar{X}\pm S$). All data used the one-way analysis of variance (ANOVA) post-multiple comparison method in the IBM SPSS Statistics 22 data editor, set the significance level to P=0.05, and used the LSD program to analyze the significant differences (P<0.05 is significant). Origin 2018 software was used to make charts.

3. Results and discussions

The cooking loss and emulsion stability of sausage after adding taro paste are shown in **Table 2**.

As shown in **Table 3**, when a portion of potato starch was replaced by a different amount of taro from the pork sausage, the cooking loss of the samples in each test group was significantly lower than in the control group. Among the five treatment groups, the cooking loss and emulsion stability of raw meat surimi with 40 % taro instead of potato starch were the best. This indicated that the addition of taro paste could reduce the cooking loss of bran pork sausage during heating. The possible reason is that the starch and dietary fiber contained in the added areca taro paste can improve the fat stability and water locking capacity of the mince to a certain extent, reducing the loss of juice from the mince during heating and effectively reducing the cooking loss rate.

Table 3
The effect of different taro paste content on the cooking loss and emulsification stability of raw meat emulsion

Treatment	Cooking loss, %	Moisture loss, %	Fat loss, %
Control	14.58 ± 0.08^{a}	4.75 ± 0.05^{a}	0.93 ± 0.04^{a}
20 %	13.58 ± 0.08^{a}	4.67 ± 0.16^{ab}	0.52 ± 0.49^{a}
40 %	9.16 ± 0.50^{bc}	4.21 ± 0.21^{bc}	0.11 ± 0.54^{c}
60 %	9.27 ± 1.73^{c}	4.37 ± 0.02^{abc}	0.20 ± 0.00^{b}
80 %	9.43 ± 0.63^{c}	4.56 ± 0.01^{c}	0.17 ± 0.00^{bc}
100 %	10.61 ± 0.69^{ab}	4.73 ± 0.02^{a}	0.23 ± 0.10^{b}

Note: Means within a column with different letters are significantly different (p<0.05).

Color is one of the important indicators reflecting the quality of meat products. Consumers can judge the quality of sausage from its color. It can be seen from **Table 4** that the yellowness (b* value) and redness (a* value) of raw surimi in the treatment group with added taro paste are lower than those in the control group, while the brightness (L* value) has no significant change, which may be caused by the fact that the color of areca taro paste is gray white, resulting in the gradual dilution of the original light red color of the surimi. With the increase of the proportion of mashed taro, the L* value of sausage increased, the b* value showed an unstable fluctuation, and the a* value did not change significantly. Therefore, the amount of mashed taro added had a significant impact on the color of bran sausage.

As shown in **Table 5**, the hardness of sausage in the control group is 163.23, which is significantly higher than that of sausage in the treatment group; In the experiment, when the proportion of taro mud was 80 %, the hardness of sausage was 82.38, which was significantly lower than other treatment groups; In terms of reversibility, there was no significant difference between the treatment group and the control group. In terms of elasticity, the measured value of elasticity of sausages in the control group was 1.61, which was significantly higher than that of other treatment groups. There was no significant difference between the measured values of elasticity of sausages in the treatment groups. In terms of stickiness and masticatory, the stickiness and masticatory of the control group were 102.39 and 175.25 respectively, which were significantly greater than those of each treatment group. In [16] speculated that the elasticity and viscosity changes of sausages may be caused by different sausage varieties and processing technologies. The result that the chewability of the sausage prepared in this test shows irregular changes is inconsistent with the change trend of the test chewability, which may be caused by different test materials [17].

Table 4
Effects of different taro paste content on chromaticity of raw meat and chicken sausage

Treatment	*L**		*a**		*b**	
	Raw meat	Sausage	Raw meat	Sausage	Raw meat	Sausage
Control	54.90±0.38[a]	60.25±0.34[e]	21.36±0.34[a]	10.15±0.34[c]	11.51±0.07[a]	12.36±0.35[a]
20 %	54.74±0.63[a]	62.79±0.13[d]	20.19±0.11[b]	11.18±0.35[b]	9.75±0.34[bc]	11.70±0.35[b]
40 %	54.81±0.09[b]	63.58±0.15[c]	20.08±0.18[b]	11.78±0.24[ab]	10.19±0.40[b]	12.38±0.66[a]
60 %	54.26±0.19[c]	65.49±0.42[b]	19.88±0.25[c]	11.59±0.12[ab]	9.28±0.37[c]	11.19±0.40[b]
80 %	54.43±0.59[bc]	65.29±0.30[b]	19.17±0.08[c]	11.86±0.11[a]	9.99±0.31[bc]	12.94±0.14[a]
100 %	54.78±0.54[b]	67.00±0.50[a]	20.41±0.47[ab]	12.06±0.31[a]	9.48±0.34[c]	12.08±0.65[a]

Table 5
Effect of different taro paste content on texture of raw minced meat

Treatment	Hardness (*N*)	Springiness	Cohesive ness	Gumminess (*N*)	Chewiness (*N*)	Resilience
Control	163.23±1.74[a]	1.61±0.54[a]	0.63±0.01[a]	102.39±2.69[a]	175.25±3.10[a]	0.04±0.00[a]
20 %	156.16±7.35[b]	1.05±0.08[a]	0.60±0.01[a]	93.13±5.03[b]	105.81±2.36[b]	0.03±0.01[a]
40 %	106.27±1.24[d]	1.19±0.19[a]	0.63±0.01[a]	66.58±1.02[c]	76.75±2.01[c]	0.03±0.00[a]
60 %	98.12±1.51[e]	1.10±0.18[a]	0.59±0.05[a]	57.70±4.01[d]	54.48±1.35[d]	0.03±0.00[a]
80 %	82.38±0.52[f]	1.19±0.27[a]	0.63±0.01[a]	49.74±0.86[d]	53.78±0.96[d]	0.03±0.00[a]
100 %	120.08±3.53[c]	1.06±0.10[a]	0.59±0.02[a]	70.30±1.20[c]	70.51±1.64[c]	0.03±0.00[a]

According to the test data, the viscosity and chewability of sausage with 20 % added to the mash were the best and the hardness was higher than other treatment groups; When the proportion of taro paste was 80 %, the hardness of bran sausage was the lowest, and the cohesion and elasticity were the best compared with other treatment groups.

In addition, Numai MRI image processing software was used for unified image processing and pseudo color processing, as shown in **Fig. 1**. The red part of the pseudo color image indicates the highest moisture content and the strongest NMR signal; The yellow part is next; The blue part is the weakest. The red area with the most water content indicates the distribution of water molecules in raw meat paste and sausage after different proportions of taro paste replace starch. With the increase of the amount of taro paste added, the red and yellow areas in the pseudo color diagram become more, and the water molecules in sausage become more obviously. This shows that the water holding capacity of meat paste and sausage is improved after taro paste replaces part of potato starch. The water distribution in the red area in the pseudo color diagram is mostly distributed in the periphery, the central position is mostly yellow, which indicates that the water distribution in various parts of the minced meat is different, which is consistent with the research results [16]. The bound water of bran sausage prepared by substituting taro for starch moves towards the direction of short relaxation time, which indicates that the content of semi bound water added to taro increases, the water retention of sausage increases, and the water that is difficult to flow and free water have no significant changes.

As shown in **Table 6**, compared with the control group, the appearance, smell, taste and overall acceptability of the sausages in the test group were slightly higher than those in the control group, but the difference was not significant. The results showed that adding taro paste was helpful to improve the appearance, smell, taste and overall acceptability of bran pork sausage to a certain extent, and the sausage in the treatment group with 40 % taro paste instead of starch had the highest score. This shows that the use of taro instead of some starch in sausage can not only reduce the loss of water, oil and nutrients, but also improve the quality characteristics of the product. Even if the starch in sausage is completely replaced by taro, the eating quality of sausage will not be adversely affected, and the overall acceptability of sausage is ideal.

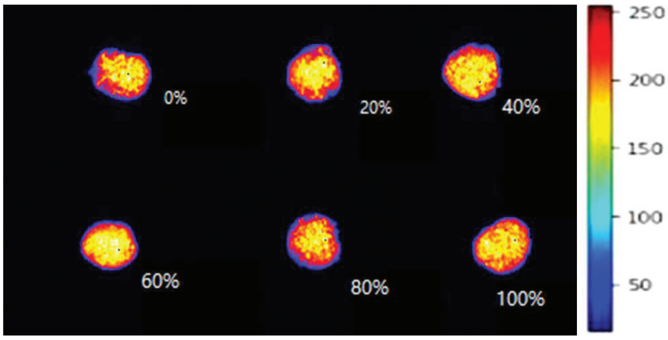

Fig. 1. Pseudo color diagram of water distribution of bran pork sausage with different amount of added taro paste

Table 6

Effect of different taro paste content on sensory evaluation score of sausage

Treatment	Color	Flavor	Viscosity	Hardness	Overall acceptance
Control	6.68 ± 0.95^{ab}	7.17 ± 0.02^{a}	6.24 ± 0.08^{b}	6.52 ± 0.02^{ab}	6.30 ± 1.06^{b}
20 %	7.05 ± 0.67^{a}	7.31 ± 0.01^{a}	7.41 ± 0.04^{a}	6.56 ± 0.03^{ab}	7.40 ± 1.43^{a}
40 %	7.14 ± 0.19^{a}	7.80 ± 0.04^{a}	7.52 ± 0.06^{a}	6.79 ± 0.01^{a}	7.57 ± 1.20^{a}
60 %	7.11 ± 0.20^{a}	7.77 ± 0.00^{a}	7.43 ± 0.19^{a}	6.79 ± 0.03^{a}	7.10 ± 1.37^{ab}
80 %	6.86 ± 1.05^{ab}	7.63 ± 0.02^{b}	7.49 ± 0.06^{a}	6.38 ± 0.01^{b}	6.90 ± 0.88^{ab}
100 %	6.16 ± 0.15^{b}	6.80 ± 0.04^{b}	6.6 ± 0.15^{b}	6.52 ± 0.04^{ab}	6.52 ± 0.04^{b}

Areca taro is rich in high-quality dietary fiber, starch, water-soluble polysaccharides, vitamins and inorganic salts, so the use of taro paste in sausage is more reasonable in nutritional composition than the use of starch. The nutritional composition results of taro paste sausage can be seen from **Table 7** that the protein content increases significantly with the increase of the proportion of taro paste, which is consistent with the results in the study and Campinas State University on fat reducing sausage [19]. Combined with the research results of Tengwei and others on taro protein content, the protein content in sausage also showed an upward trend in this experiment, from 10.68 % to 28.16 %, with the increase of the proportion of taro paste added. With the increase of the proportion of mashed taro, the pH value of bran pork sausage rises slowly. The results show that the addition of mashed taro increases the pH value of bran pork sausage, which is consistent with the conclusion that areca taro belongs to alkaline food. The ash content of bran sausage after potato starch was replaced by taro paste showed an obvious increasing trend, from 1.67 % to 1.94 %, mainly because taro paste was the whole component of plants compared with purified starch. In addition, although the moisture content of bran pork sausage increased after adding taro mud, there was no significant difference, and the fat content was significantly lower, which was similar to the research results [20].

Table 7

Effect of different taro paste content on nutrients and pH of sausage

Treatment	Protein	Ash	Moisture	pH	Fat
Control	10.68 ± 0.95^{d}	1.67 ± 0.02^{c}	56.24 ± 0.06^{d}	6.25 ± 0.02^{c}	17.68 ± 0.65^{a}
20 %	25.05 ± 0.67^{c}	1.77 ± 0.01^{b}	56.41 ± 0.04^{d}	6.38 ± 0.03^{b}	15.05 ± 0.07^{b}
40 %	25.14 ± 0.19^{c}	1.80 ± 0.04^{b}	57.12 ± 0.06^{c}	6.39 ± 0.01^{b}	11.14 ± 0.09^{c}
60 %	26.05 ± 0.20^{ab}	1.81 ± 0.00^{b}	57.33 ± 0.05^{b}	6.39 ± 0.03^{b}	8.05 ± 0.27^{d}
80 %	26.86 ± 1.05^{ab}	1.93 ± 0.02^{a}	57.49 ± 0.06^{a}	6.52 ± 0.01^{a}	8.86 ± 1.05^{d}
100 %	28.16 ± 0.15^{a}	1.94 ± 0.04^{a}	57.56 ± 0.05^{a}	6.62 ± 0.04^{a}	6.16 ± 0.15^{d}

Taro paste replaces part of starch, improving the nutritional composition of sausage, but the dietary fiber in taro paste also affects the texture characteristics of sausage. In the next step, it is necessary to change the gel properties of sausage by adding gelatin or pigskin and other substances.

4. Conclusions

The results showed that with the increase of the proportion of starch replaced by taro, the pH of protein, ash and water content in the sausage of the treatment group increased gradually, while the fat content decreased; cooking loss, water loss and fat loss decreased significantly; the brightness (L^* value) of sausage increased, the yellowness (b^* value) showed an unstable fluctuation of decreasing and increasing, and the redness (a^* value) did not change significantly; the hardness and viscosity of sausage decreased significantly, but the elasticity and resilience did not change significantly; the water in sausage moved towards the direction of shortening relaxation time; the sensory evaluation results showed that the sausage of all treatment groups had the best score on the overall acceptable level, especially the sausage with taro instead of 40 % starch.

When the amount of taro paste was 40 %, the cooking loss of sausage was the smallest, the emulsion stability was the best, the hardness and chewiness were moderate, and the elasticity was the best.

After using areca taro mash to replace potato starch in sausages, the nutritional value of sausages was improved firstly, the tissue structure and taste of sausages were improved secondly, and the fat content of sausages was reduced finally, and the prepared sausages were acceptable in terms of sensory evaluation. This study provided data and theoretical parameters for the application of taro paste in sausage.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was performed without financial support.

Data availability

Manuscript has data included as electronic supplementary material.

References

[1] Choi, Y.-S., Kim, H.-W., Hwang, K.-E., Song, D.-H., Jeong, T.-J., Kim, Y.-B. et al. (2015). Effects of fat levels and rice bran fiber on the chemical, textural, and sensory properties of frankfurters. Food Science and Biotechnology, 24 (2), 489–495. doi: https://doi.org/10.1007/s10068-015-0064-5

[2] Zhang, J. M., Li, J. J., Xu, S. M. et al. (2019). Study on formula optimization of low-fat smoked and boiled sausage. Agricultural Product Processing, 17, 46–50. doi: https://doi.org/10.16693/j.cnki.1671-9646(X).2019.09.011

[3] Hu, F. Y., Chen, J. Y., Zhang, K. S., Xu, S. H., Geng, Y. X. (2022). Preparation of resistant starch by ultrasound and its effect on sausage quality and glycemic index. Chinese Journal of Food, 22 (04), 125–138. doi: https://doi.org/10.16429/j.1009-7848.2022.04.013

[4] Tang, X. T., Liu, Q., Kong, B. H. et al. (2014). Research progress on the classification and application of fat substitutes in food. Food Industry, 35 (05), 190–195. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SPGY201405058&DbName=CJFQ2014

[5] Zhang, H. Y., Dong, S. T., Gao, R. Q. (2006). Research progress of plant starch. Chinese Journal of Cereals and Oils, 1, 41–46. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=ZLYX200601009&DbName=CJFQ2006

[6] Liu, H., Xiong, Y. L., Jiang, L., Kong, B. (2008). Fat reduction in emulsion sausage using an enzyme-modified potato starch. Journal of the Science of Food and Agriculture, 88 (9), 1632–1637. doi:https://doi.org/10.1002/jsfa.3260

[7] Wang, F. G., Wei, Y. Y., Dou, K. N. (2016). Research on the application of modified starch in sausage processing technology. Meat Industry, 1, 36–38. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=RLGY201601011&DbName=CJFQ2016

[8] Han, B., Du, M., Wang, C., Xu, S. L., Ye, T. H., Yu, C. (2012). Properties of potato oxidized starch and its influence on Harbin sausage quality. Food Industry Science and Technology, 33 (11): 169–171. doi: https://doi.org/10.13386/j.issn1002-0306.2012.11.059

[9] Sousa, S. C., Fragoso, S. P., Penna, C. R. A., Arcanjo, N. M. O., Silva, F. A. P., Ferreira, V. C. S. et al. (2017). Quality parameters of frankfurter-type sausages with partial replacement of fat by hydrolyzed collagen. LWT - Food Science and Technology, 76, 320–325. doi: https://doi.org/10.1016/j.lwt.2016.06.034

[10] Mitharwal, S., Kumar, A., Chauhan, K., Taneja, N. K. (2022). Nutritional, phytochemical composition and potential health benefits of taro (Colocasia esculenta L.) leaves: A review. Food Chemistry, 383, 132406. doi: https://doi.org/10.1016/j.foodchem.2022.132406

[11] Du, X. J., Chen, F. H., Wu, G. B. (2012). Study on physical properties of areca taro starch. Chinese Journal of Cereals and Oils, 7, 52–57. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=ZLYX201207014&DbName=CJFQ2012

[12] Jiang, S., Niu, H. L., Liu, Q. et al. (2018). Effect of curdlan and water addition on quality characteristics of frankfurters. Food Science, 39 (14), 57–66. doi: https://doi.org/10.7506/spkx1002-6630-201814009

[13] Colmenero, F. J., Ayo, M. J., Carballo, J. (2005). Physicochemical properties of low sodium frankfurter with added walnut: effect of transglutaminase combined with caseinate, KCl and dietary fibre as salt replacers. Meat Science, 69 (4), 781–788. doi: https://doi.org/10.1016/j.meatsci.2004.11.011

[14] Chen, Y., Jiang, S., Cao, C., Chen, J., Kong, B., Liu, Q. (2019). Evaluation of the Quality of Frankfurters Prepared with Highly Stable Vegetable Oil-in-Water Pre-Emulsion as a Partial Replacer of Pork Back Fat. Food science, 40 (24), 86–93. doi: https://doi.org/10.7506/spkx1002-6630-20180906-060

[15] Sun, W. B., Luo, X., Zhang, Y. M. et al. (2019). Research progress in the application of low field NMR in the determination and analysis of moisture in meat and meat products. Food Science, 40 (15), 346–351. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=SPKX201915047&DbName=CJFQ2019

[16] Chen, J. X., Pei, S. L. (2012). Research on the application of different kinds of modified starch in sausage. Meat Industry, 8, 23–24. Available at: https://kns.cnki.net/kcms/detail/detail.aspx?FileName=RLGY201208008&DbName=CJFQ2012

[17] Aktaş, N., Gençcelep, H. (2006). Effect of starch type and its modifications on physicochemical properties of bologna-type sausage produced with sheep tail fat. Meat Science, 74 (2), 404–408. doi: https://doi.org/10.1016/j.meatsci.2006.04.012

[18] Gai, S., You, J., Zhang, X. et al. (2020). Discrimination of Water-injected Ground Meat Using Low-field Nuclear Magnetic Resonance and Magnetic Resonance Imagin. Food Science, 2020, 41 (22), 289–294. doi: https://doi.org/10.7506/spkx1002-6630-20190709-129

[19] Gao, Y. L., Zhang, L., Yu, Q. L., Han, L. (2021). Research Progress in Animal Fat Substitutes and Their Applications in Meat Products. Food and Fermentation Industry, 47 (15), 315–324. doi: https://doi.org/10.13995/j.cnki.11-1802/ts.025769

[20] Li, J. K., Peng, Z. Q., Hou, Q. et al. (2017). Effect of taro and carrageenan combination system on the quality of pork cakes. Food Industry Science and Technology, 38 (11), 76–81. doi: https://doi.org/10.13386/j.issn1002-0306.2017.11.006

Received date 02.10.2022
Accepted date 14.11.2022
Published date 30.11.2022

How to cite: *Kryzhska, T., Shang, F. F. (2022). Effects of taro paste on physicochemical properties and nutritional components of bran pork sausage. EUREKA: Life Sciences, 6, 52–59, doi: http://doi.org/10.21303/2504-5695.2022.002694*