ТЕХНІЧНІ НАУКИ

UDC 637.522; 637.523

EFFECTS OF DIFFERENT DUCK MEAT AND WHEAT BRAN CONTENTS ON THE QUALITY CHARACTERISTICS OF SAUSAGES

***Shang Feifei*[1,2]**, *Postgraduate,*
Department of Technology and Food Safety
https://orcid.org/0000-0001-7648-9568
***Tetiana Kryzhska*[1]**, *PhD, Technics, Senior Lecturer,*
Department of Technology and Food Safety,
https://orcid.org/0000-0001-7151-9799
***Svitlana Danylenko*[3]**, *D-r of Sciences, Technics, Senior Research*
Head of Department of Biotechnology,
https://orcid.org/0000-0003-4470-4643
***Nina Usatenko*[4]**, *PhD, Technics, Senior Lecturer of the Department*
of Vocational Education (Food Technology)
https://orcid.org/0000-0002-0339-5189
***Duan Zhenhua*[2]**, *PhD, Technics, Professor Department of Food and Biological Engineering,*
https://orcid.org/0000-0002-9283-3629
[1]*Sumy National Agrarian University, Sumy, Ukraine;*
[2]*Department of Food and Bioengineering, Hezhou University, China,*
[3] *Institute of Food Resources of NAAS, Kyiv, Ukraine*
[4]*Pereyaslav-Khmelnytsky State Pedagogical*
University GS Skovoroda, Pereyaslav, Ukraine

https://doi.org/10.31073/foodresources2021-17-01

The purpose. *Wheat bran is rich in dietary fiber (31,4%) and protein (18%), and fat is only 0,6%. This is data from a Chinese laboratory. Wheat bran is an excellent ingredient that can balance the nutrients in food. The protein composition of duck meat is also very different from that of pork. Therefore, an emulsified sausage is made with duck meat, pork, bran, and corn starch as the main raw materials.* ***Research methods.*** *First determine the proportion of duck meat instead of pork (0, 10%, 20%, 30%, 40%), and then add wheat bran to the mixed meat emulsion at 0,6%, 1,2%, 1,8%, and 2,4%. By analyzing the cooking loss, emulsification stability, color, pH, texture characteristics, sensory evaluation and other parameters of sausage, the best formula composition for sausage manufacturing is determined.* ***Research result.*** *The effect of different proportions of lean pork and duck breast on the quality characteristics of sausages, 40% of duck meat instead of pork can achieve good water retention, while cooking loss and moisture loss are reduced. The addition of bran increased the viscosity, chewiness, hardness, elasticity, cohesion and recovery of sausages. Among them, the viscosity of the Y2 group with 1,2% bran (6g bran/without 500g raw meat) was increased. The chewiness and hardness are the greatest, and the sensory evaluation is also the best.* ***Conclusion.*** *40% duck breast is substituted for pork and 1,2% bran is added. The sausage produced is well evaluated, and it does not significantly change the physical properties of the sausage. The research results provide a reference for the development of new Ukrainian sausage products.*

Keywords: *Duck and Pork Compound Sausage, wheat bran, Sausage processing, cooking loss, sensory evaluation*

ВПЛИВ РІЗНОГО ВМІСТУ М'ЯСА КАЧКИ ТА ПШЕНИЧНИХ ВИСІВОК НА ЯКІСНІ ХАРАКТЕРИСТИКИ КОВБАС

Шан Фейфей[1,2]*, аспірант*
кафедри технологій та безпечності харчових продуктів,
https://orcid.org/0000-0001-7648-9568
Крижська Т.А.[1]***,*** *к.т.н., старший викладач*
кафедри технологій та безпечності харчових продуктів,
https://orcid.org/0000-0001-7151-9799
Даниленко С.Г.[3]***,*** *д.т.н., с.н.с.,*
зав. відділу біотехнології
https://orcid.org/0000-0003-4470-4643
Усатенко Н. Ф.[4]*, к.т.н., старший викладач кафедри*
професійної освіти (харчові технології)
https://orcid.org/0000-0002-0339-5189
Дуань Чженьхуа[1]***,****к.т.н.,*
професор кафедри харчування та біоінженерії
https://orcid.org/0000-0002-9283-3629
[1]Сумський національний аграрний університет, м. Суми, Україна
[2]Кафедра харчування та біоінженерії, Університет Хечжоу, Китай
[3]Інститут продовольчих ресурсів НААН, м. Київ, Україна
[4]Переяслав-Хмельницький державний педагогічний
університет ім. Г. С. Сковороди, м. Переяслав, Україна

https://doi.org/10.31073/foodresources2021-17-01

Мета. *Пшеничні висівки багаті харчовими волокнами (31,4%) і білком (18%), а жирів – лише 0,6%. Це дані китайської лабораторії. Пшеничні висівки є інгредієнтом, який може збалансувати поживні речовини в їжі. Білковий склад м'яса качки також сильно відрізняється від свинини. Саме м'ясо качки, свинини, висівки, кукурудзяний крохмаль було взято як основну сировини для виготовлення емульгованої ковбаси.* ***Методи дослідження.*** *Спочатку визначали частку качиного м'яса замість свинини (0, 10%, 20%, 30%, 40%), а потім додавали пшеничні висівки до м'ясної емульсії 0,6%, 1,2%, 1,8% і 2,4%. Аналізували втрати від кулінарної обробки, стабільність емульгування, колір, pH, характеристики текстури, визначали сенсорну оцінку та інші параметри ковбаси, визначили оптимальну рецептуру для виробництва ковбас.* ***Результат дослідження.*** *Досліджено вплив різних пропорцій нежирної свинини та качиної грудки на якісні характеристики ковбас. Показано, що 40% качиного м'яса замість свинини дозволяє досягти необхідного утримання води, при цьому зменшити втрати при варінні та втрати вологи. Додавання висівок підвищило в'язкість, жувальну здатність, твердість, еластичність, зчеплення та відновлення ковбас. Серед них підвищена в'язкість групи Y2 з висівками 1,2% (6г висівок/ 500г сирого м'яса). Жувальність і твердість є найбільшою, а сенсорна оцінка - найкраща.* ***Висновок****. Оптимальним є заміна свинини на 40% качиної грудки та додати 1,2% висівок. Саме це не істотно змінює фізичні властивості ковбаси. Вироблена ковбаса має високу сенсорну оцінку. Результати дослідження є орієнтиром для розробки нових українських ковбасних виробів.*

Ключові слова: *качино-свиняча складова, ковбаса, висівки пшеничні, переробка ковбаси, втрати за кулінарної оброки, сенсорна оцінка*

Sausage is one of the most popular meat products in the world. Ukrainian poached smoked cooked sausages, Harbin red sausages in China, Sichuan spicy sausages, Frankfurt sausages, hot dogs and other world-famous ones. Poultry meat is a kind of high-protein and low-fat meat food. Duck meat has high nutritional value, with protein as high as 16%~25%, which is the highest protein content in livestock food. The protein in duck meat is mainly sarcoplasmic protein and myosin. There are also some interstitial proteins, which contain water-soluble collagen and elastin, in addition to a little gelatin, and the rest are nitrogen-containing compounds. Food experts believe that the more nitrogen-containing compounds leached from food, the better the taste. The fat content of duck meat is lower than that of pork, and it is evenly distributed in the tissues. It contains a large amount of unsaturated fatty acids, which enter the human body and are easy to digest. The ratio of protein to fat is high, and it is a high-quality meat for weight control people, elderly people who limit fat intake, and patients with vascular sclerosis tendency [1].

Different raw materials have significant effects on the quality characteristics and flavor of sausages. Most of the sausages are made with pork as the main raw material, but with the development at home and abroad, sausages made with chicken, duck, mutton and rabbit meat as raw materials have also appeared. In recent years, the duck industry in various places has risen rapidly, and a large number of them have been exported to Japan, South Korea, Europe and other places, providing a direction for the development of duck meat products [2]. Therefore, it is also a way to make duck meat into sausage as a popular food.

Wheat bran is an important by-product in the process of making flour. Data from Chinese laboratories show that wheat bran is rich in dietary cellulose (31.4%) and protein (18%), and fat is only 0.6%. Wheat bran is an excellent ingredient that can balance the nutrients in food. The addition of wheat bran dietary fiber to sausages allows people to supplement the lack of dietary fiber while ingesting meat, improving nutrition and health. Research by Jing Y S et al. showed that adding different concentrations of dietary fiber suspension to Frankfurt sausages increased the viscosity of the sausages but decreased the pH, without affecting the cooking loss, protein and collagen content and sensory evaluation of the sausages [3]. Gao Xiaoguang et al. studied the effect of purified wheat bran dietary fiber on the quality of emulsified sausages and showed that sausages made with 6% wheat bran dietary fiber added to pork (fat to lean ratio 1:9) have good taste and excellent color and other parameters. The sensory properties and nutritional properties are improved.[4]

Materials and Methods. Chinese teal's duck meat and lean pork meat, corn starch, spices, pepper, salt, Guilin Sanhua rice wine, red yeast rice powder, compound phosphate, and natural pig casings were purchased at the Hezhou city agricultural product market in China. Beet red comes from the Food Engineering Research Institute of Hezhou University. The Wheat bran was got from Henan Jinyuan Grain & Oil Company of Zhengzhou city, and the Wheat bran was crushed and sifted (part below 80 mesh).

Processing of sausage: Duck breast meat and pork were chopped and mixed, and the ingredients (Corn starch, spices, ice water, wheat bran, pigment) were mixed with minced meat, and the raw materials were put into the sausage casing with filling equipment and divided into sections with cotton thread for use. The product formula was shown in Table 1 and 2.

Table 1

Sausage treatment scheme with different proportions of lean pork and duck breast

Ingredients (g)	T0	Treatment			
		T1	T2	T3	T4
Pork meat	500	450	400	350	300
Duck meat	0	50(10%)	100(20%)	150(30%)	200(40%)
Ice water	100	100	100	100	100
Rice wine	20	20	20	20	20
Corn starch	70	70	70	70	70
Other ingredients	15	15	15	15	15

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

Table 2

Experimental plan for the effect of different bran content on pork and duck sausages

Ingredients (g)	Y0	Treatment			
		Y1	Y2	Y3	Y4
Pork meat	300	300	300	300	300
Duck meat	200	200	200	200	200
Wheat bran(80mesh)	0	3	6	9	12
Ice water	100	100	100	100	100
Rice wine	20	20	20	20	20
Corn starch	70	70	70	70	70

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

Cooking loss: Refer to the method of Jiang Shuai [5]. Weigh 35g minced meat into a 50ml centrifuge tube and centrifuge (3000 rpm, 5min) to remove air bubbles in the tube. Then, heat it in a water bath (75°C, 30min), 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 formula:

$$Cooking\ loss\ (\%) = \frac{weight\ of\ raw\ meat\ batters\ (g) - weight\ of\ cooked\ meat\ batters\ (g)}{weight\ of\ raw\ meat\ batters\ (g)} \times 100 \quad (1)$$

Emulsion stability: 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 [6,7]. The calculation of water loss and fat loss is shown in formulas:

$$Moisture\ loss(\%) = \frac{Weight\ of\ Cooking\ liquid - Remaining\ weight\ after\ heating}{Weight\ of\ raw\ meat\ batter} \times 100 \quad (2)$$

$$Fat\ loss(\%) = \frac{weighRemaining\ weight\ after\ heating}{Weight\ of\ raw\ meat\ batter} \times 100 \quad (3)$$

Color: Place the sausages stored at 4°C at room temperature to equilibrate for 1 hour. The color of each uncooked meat batter and cooked sausage was determined using a Colorimeter (color difference meter CR-400; calibrated with a white plate, L*= +97.83, a*= −0.43, b*= +1.98). Used the colorimeter and O/D test head to determine the brightness value (L*), redness value (a*) and yellowness value (b*).

pH: A sample of 5 g sausage (minced meat) was crushed, put into a 50 mL beaker, 20 mL of

distilled water was added, magnetically stirred for 5 min, and static for 30 min. Use a pH meter to measure the intermediate liquid. After the reading is stable, read directly and record the data. A set of parallel determinations three times, take the average value.

Texture profile analysis: The test method refers to the method of Chen Yichun, et al. [7] with a slight modification. The sausage is removed from the casing, cut into a cylinder and placed on the TA-XT plus physical property tester for measurement. The test conditions are as follows: when the sample is sausage, the probe is selected as P/5, the rate before the test is 5 mm/s, the test rate is 1 mm/s, the test rate is 1 mm/s, 50% The compression ratio, 5 g trigger force. The measurement contents mainly include hardness, Springiness, cohesiveness, Gumminess, chewiness, and resilience.

Moisture: Drying with 102℃ hot air for moisture content determination to constant weight [8].

Sensory evaluation: Ten food technology graduate students were invited to conduct sensory evaluations of sausages, cut the sausages into cylindrical shapes, and evaluate the color, taste, taste, and tissue state of the sausages. Therefore, the overall acceptability is obtained. The highest evaluation index is 9 points, and the lowest is 1 point, and the best group is selected according to the given score. The evaluation criteria are shown in Table 3.

Table 3

Sensory Evaluation Standard

Evaluation item	7~9 score	4~6 score	1~3 score
Color	Maroon, appetite, shiny	Light red, normal appetite, shiny	Abnormal color, no appetite, shiny
Flavor	Intestines have obvious flavor	Intestines have a weak flavor	Almost no intestine flavor
Texture	Good firmness, elasticity and resilience	Normal firmness, elasticity and resilience	Lack of firmness, elasticity, resilience
Taste	Fine taste and good chewiness	Slightly rough mouthfeel, average chewiness	Rough taste and poor chewiness
Integrated grade	Accept	General	Not accept

Dynamic distribution of moisture: Refer to the method of Zhang Mingcheng [9] with a slight modification to determine the moisture distribution. Cut the sausage into a cuboid, wrap it in plastic wrap, and put it in an NMR test tube (diameter 1.8 cm, height 18 cm). The magnetic field strength of the NMI20 NMR imaging analyzer is 0.47 T, and the proton resonance frequency is 20 MHz. Use the Carr-Purcell-Meiboom-Gill program to determine the low-field NMR relaxation time (T2) of the sausage sample. The instrument will automatically scan 16 times during scanning, and the time interval for each scan is 2 s. The T2 measured by the sausage is directly inverted in the Contin software to obtain the relaxation time and amplitude of the sample.

Statistical analysis: The measurement index is repeated 3 times, and the data results are all expressed as mean ± standard deviation (X ± S). Use Microsoft Excel 2017 software to draw charts.

Results and Discussion. The effect of different duck meat additions on the sensory quality, cooking loss, moisture and fat loss and hardness of sausages was shown in Table 4. As the content of duck meat increases, the sensory scores show an upward trend. The score of the T4 group reaches 6.15 scores. It was because the protein and water content of duck meat is higher than that of pork, so the taste will increase, and people can accept its flavor more. The cooking loss of the duck meat treatment group increased first and then decreased. When the addition amount reached 30%, the cooking loss, water loss and fat loss reached the maximum, that is, adding 30% duck meat would greatly reduce the water holding capacity of the sausage. Capacity: When duck meat is added to 40%, cooking loss and water loss are significantly reduced

compared with the control group. The results show that when duck meat replaces pork up to 40%, the cooking loss and moisture loss of sausages during heating can be reduced. Improve the water retention of sausages. The texture properties affect the quality of sausages. The research results show that replacing part of pork with duck meat reduces the hardness and cohesion of sausages (except T2). This may be due to the fact that the protein in duck meat is more water-retaining and better than pork. Uniformity, thereby reducing the hardness and improving the elasticity of the product. In summary, in the T4 treatment group, 40% of duck meat was replaced by pork, which is an ideal formula.

Table 4

Research on the effect of different duck meat addition on the quality of sausage

Treatments	Color	Flavor	Texture	Taste	integrated grade	Cooking loss,%	Water loss,%	Fat loss,%	Hardness, N
T0	5.8	5.9	5.6	5.2	5.62±0.27	0.63	0.29	0.03	96.5±4.55
T1	5.4	5.9	5.6	5.4	5.57±0.20	0.77	0.51	0.09	64.6±6.64
T2	6	5.8	5.7	5.6	5.77±0.15	1.06	0.63	0.09	97.6±15.42
T3	5.8	6.4	5.7	5.9	5.95±0.27	1.20	0.97	0.14	90.5±11.23
T4	6.5	6.1	5.6	6.4	6.15±0.35	0.49	0.11	0.06	76.26±2.60

Based on the previous research foundation, the effect of adding different amounts of bran on the quality characteristics of sausages was further studied. The results in Table 5 show that the cooking loss and water loss of the treatment group Y1-Y4 with the addition of bran were significantly increased compared with the control group, and the fat loss results were also the same (except for Y3). This is because the cellulose in the bran increases the pores of the protein gel network, causing the cooking loss rate to gradually increase with the increase in the amount of bran [10].

The brightness value L* of the T1 treatment group increased, and the other 3 groups changed slightly compared with the control. With the increase of the amount of bran, its yellowness value b* increased slightly. In addition, the redness value a* in the T3 treatment group decreased, but overall the chromaticity value did not change much. The small amount of bran added did not affect the color of the sausage to change significantly. With the increase of the addition amount, the pH value increases slightly, but the difference was not obvious.

Table 5

Effect of bran addition on Cooking loss, Emulsion stability, Color and pH of sausage

Treatments	Cooking loss, %	Water Loss, %	Fat Loss, %	L*	a*	b*	pH
Y0	0.49	0.11	0.06	53.77±0.29	18.15±0.37	17.43±0.31	5.62±0.01
Y1	1.34	0.51	0.09	56.40±1.47	17.35±0.94	18.2±1.19	5.62±0.02
Y2	2.06	0.63	0.09	53.09±0.1	17.46±1.89	20.11±1.65	5.76±0.01
Y3	3.06	2.34	0.03	54.60±0.29	16.57±0.55	20.01±0.18	5.66±0.02
Y4	5.11	0.71	0.09	54.37±0.39	18.16±0.15	20.84±0.49	5.63±0.01

The results of the study in Table 6 was shown that the addition of bran increases the viscosity, chewiness, hardness, elasticity, cohesion, and recovery of sausages, except for the Y1 treatment group, and the viscosity, chewiness, and hardness of the Y2 treatment group maximum. The Y1 treatment group had the highest flexibility and cohesion, and the recovery was second only to the Y3 group. The hardness of sausages is affected by the changes of moisture, food matrix, protein and cellulose, and dietary fiber has a strong water absorption capacity. Adding bran to the sausage is beneficial to improve the support of the tissue structure and improve the toughness of the meat. Spend. Song Dawei, et al. believed that excessive dietary fiber additions would easily lead to the breakdown of the gel system formed by fiber and protein. [11] In

summary, the Y2 treatment group sausages had the best gel properties, the highest chewiness and hardness values, moderate elasticity and resilience, and the best texture properties of the sausages.

Table 6

Effect of bran addition on TPA (Texture profile analysis) of sausage

Treatments	Hardness	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
Y0	76.26±2.60	0.48±0.06	0.27±0.04	20.72±3.13	10.07±2.69	0.057±0.01
Y1	66.73±1.96	0.75±0.16	0.44±0.07	29.18±4.47	22.93±7.73	0.13±0.03
Y2	134.43±25.18	0.68±0.06	0.38±0.06	52.32±16.53	34.54±8.20	0.09±0.03
Y3	90.73±14.64	0.61±0.02	0.41±0.01	37.08±5.31	22.68±3.92	0.14±0.01
Y4	101.63±5.33	0.58±0.01	0.38±0.03	38.75±5.41	22.49±3.51	0.10±0.01

The moisture content of the sausages in the Y0-Y4 treatment group were: 56,97%, 61,07%, 57,37%, 60,56%, 65,15%. The moisture content of the sausages in the Y0-Y4 treatment group were: 56,97%, 61,07%, 57,37%, 60,56%, 65,15%. The moisture content of sausages with bran increased. The relaxation time results in Figure 1 below was shown that the relaxation time of sausages Y1-Y4 with bran added has shifted to the left, indicating that the semi-bound water increases, and the bran can combine with water to form semi-bound water, maintaining the moisture of the sausage. The results of the study on moisture content were consistent.

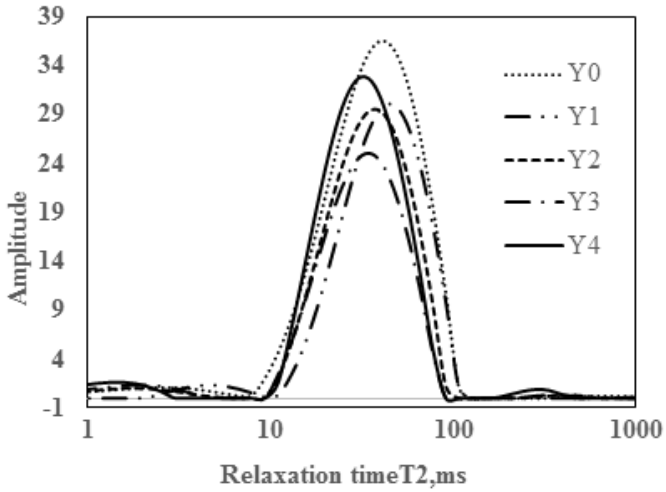

Fig. 1. Effects of wheat bran Additions on Water Distribution in Duck and pork Sausage

The results of the study in Table 7 show that with the increase of the amount of bran, the sensory scores of sausages increased first and then decreased. The sensory score of the Y2 treatment group reached the maximum. In summary, 500g duck and pork mixed sausage with 6g wheat bran (Y2) has the highest sensory quality evaluation.

Table 7

Effect of bran addition on Sensory evaluation of sausage

Treatments	Color	Flavor	Texture	Taste	integrated grade
Y0	5.7	5.8	5.4	5.4	5.57±0.18
Y1	5.5	5.3	6.1	6	5.72±0.33
Y2	5.9	7.2	6.6	7.3	6.75±0.56
Y3	5.5	6.2	6	5.6	5.82±0.29
Y4	5.7	6	6.2	6.2	6.02±0.20

Conclusion. Too much nutrition and fat have adverse effects on health. Obesity and coronary heart disease are increasing. The development of nutritionally comprehensive sausage products is an important research direction. While changing the composition of raw meat and increasing dietary fiber to change the nutritional composition, this research pays more attention to the characteristics of sausages.

The effect of different proportions of lean pork and duck breast on the quality characteristics of sausages, 40% of duck meat instead of pork can achieve good water retention, while cooking loss and moisture loss are reduced. The addition of bran increased the viscosity, chewiness, hardness, elasticity, cohesion and recovery of sausages, and the viscosity of the Y2 group with 1.2% bran (6g bran/without 500g raw meat). The chewiness and hardness are the greatest, and the sensory evaluation is also the best.

The research results can provide a reference for the development of new Ukrainian sausage products.

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