www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(8): 2025-2029

www.thepharmajournal.com
Received: 08-05-2023
Accepted: 13-06-2023

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Comparative study of Manipuri's cooked pork sausages under different cooking period, corn starch and its physicochemical analysis

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Abstract
The goal of the study was to create functional sausage from pork meat that was cooked for 17–32 minutes and replaced the fat with corn starch (6.89–28.11%). The physico-chemical quality of the corn starch-incorporated pork sausages was assessed using 13 variants that were optimised using response surface methods. These variables included moisture content (45.21-61.43)%, protein content (9.78-13.28)%, fat content (2.9- 3.65)%, cooking loss (6.53-21.31)% and process yield (78.18-93.46)%.

Keywords: Cooked pork sausages, physico-chemical quality, moisture content, fat content, protein content, cooking loss

1. Introduction

The development of healthier food options without sacrificing flavour and texture has gained increasing focus in recent years. One of the world's most popular foods, sausages, frequently have a high fat content that adds to their rich flavour. However, the traditional sausages' high fat content raises questions about how it will affect people's health. In order to develop healthier substitutes, researchers and food scientists have focused on discovering adequate fat replacements. The adoption of new non-meat ingredients has been prompted by the rising demand for healthier, higher-quality meat products (Aktaş and Gençcelep, 2006). These hydrocolloids, also referred to as structural additives or synthetic or natural non-meat components, serve a purpose in meat products as part of the processing and preservation process (Baranowska *et al.*, 2004) [12].

Direct replacement of fat with non-meat proteins for the purpose of reducing fat is an approach that is tempting due to the excellent functional and nutritional properties of these non-meat proteins. According to Pietrasik (1999) [17], starches are multifunctional food additives having a range of functional purposes, including adhesion, binding, emulsion stabilisation, gelling, and moisture retention. According to Carballo *et al.*, (1995) [7, 8] higher levels of starch had a positive impact on cooking loss and purging loss. Dexter *et al.*, (1993) [9] discovered that using modified food starch to cut turkey bologna was very effective in reducing cooking loss and reducing purging loss during storage without altering product hardness.

Corn starch, a carbohydrate fat substitute, is well known for its capacity to bind water. By binding water and lowering rubberiness, it works well in high moisture systems like meat emulsions and low-fat spreads. (Giese, 1996) [10]. According to Yang *et al.*, (2001) [16], low-fat frankfurters made with modified waxy corn starch showed the lowest purge loss (3.8%) and best emulsion stability as compared to the control.

The doneness and tenderness of sausages are greatly influenced by cooking time in addition to corn starch. In addition to producing desired sensory qualities, proper cooking assures food safety. Sausages that have been overcooked may be harsh and dry, have unpleasant textures, and even pose health risks. Finding the ideal cooking time is therefore crucial for producing sausages of the highest calibre.

It is important to keep in mind that the amount of time required for cooking depends on the size and kind of sausages. Typically, narrower sausages cook quicker than thicker ones. Additionally, the cooking time and the flavour and texture of sausages produced by various cooking techniques, such as grilling, baking, or pan-frying, might vary.

2. Materials and Methodology

2.1. Experimental Design

This study focused on cooked sausages made with the primary herbs (winged prickly ash leaves and culantro), the ratio of meat to fat, and the percentage of corn starch. The project layout is carried out in Design-Expert 7.0.0 with 2 Factors 5 Respones. Factor 1: Boiling time and Factor 2: Corn starch percent along with the Response 1: Protein %, 2: moisture content (%), 3 Fat Contents%, 4: Cooking loss (%), 5: Process yield (%). The design gave 13 samples with duration of cooking time ranges from 17.93 to 32.07 minutes and corn starch percent from 6.89 to 28.11%. A completely random design was used in the statistical analysis, which was accomplished using the Central Composite Design of the Response Surface Method and State-Ease Expert software. Analysis of Variance (ANOVA) was used to assess data collected while working. Dr. R. A. Fisher invented this method in 1923. At a 5% level of significance, the test's significance was evaluated using a probability value or p-value. Values greater than 0.5 were deemed to be 'not significant'.

2.2. Procurement of raw materials & preparation

A Study was conducted at College of Food Tech Imphal (COFT) CAU Manipur. Raw materials were purchased from local market at Imphal and Bishnupur. A fresh deboned pork meats were obtained 24 hours postmortem from the carcass. Fats and lean meat were mixed together during the purchase which were separated later before the processing. Separately pooled lean meats and carcass fat trimmings were pulverized through 1,27 cm plate. The minced meats were stored in 4 °C till the processing. Tasty Nibbles Brand corn stach were used as sausage binders which contain 9% of protein.

Table 1: Sample Formulation Table

Ingredient	Percentage
Lean meat	90
Fat	10
Corn starch	7-28
Ice water	10
Salt	3
Cayenne pepper	0.5
Ginger	0.3
Garlic	0.3
Winger Prickly Ash & Culantro	5

The key herbs (Winged Prickly Ash leaves & Culantro) based on Manipur Traditional sausage, salt (NaCl), garlic, ginger, cayenne pepper, fat, cold ice water and the ground meat itself were added. In a bowl, the entire mixer was combined to make dough. According to the chart provided by the design expert, corn starch was put in separate amounts. For the proximate analysis (Crude protein, fat, and moisture content %), 90 gm of the lean meat were taken, and another 10 gm of fat were added to round up to 100 gm. Using a stuffer, sausage batter or combinations were put into casings. After linking, labelling and chilling overnight.

2.3. Moisture content (%)

The moisture content of the sample was ascertained using the AOAC Official Method. This technique offers a standardised method for precisely determining how much moisture is present in a sample. The drying process for the moisture analysis normally entails heating the sample in an oven at a set temperature under controlled conditions until a constant weight is reached. The moisture content of the sample is represented by the weight lost during the drying process. Because the AOAC Official Method for Moisture Analysis guarantees consistency, dependability, and comparability of results, it is a crucial tool for quality assurance, legal compliance, and food industry research.

$$\text{Moisture Content \%} = \frac{(W_1 - W_2)}{W_1} \times 100 \qquad (1)$$

2.4. Fat content (%)

The sample was acid hydrolyzed with HCL to assess the crude fat content, and the hydrolyzed lipid components were then extracted with a mixture of ethers. The lipid residue is heated to a constant weight of 100° after the ethers have been evaporated. Crude protein is the expression of residue. The AOAC 1995 technique was used to calculate total fat. Petroleum ether BP 100 to 190 was used to extract a 3 grams sample for two hours in the Socs Plus Solvent/Fat extraction machine.

$$\text{Fat Content (\%)} = \frac{W_2 - W_1}{\text{Weight of the sample}} \times 100 \qquad (2)$$

2.5. Protein content (%)

The Kjedahl technique was used to determine the sample's protein content in accordance with the AOAC 2000 procedure. This approach is based on determining the nitrogen concentration of the sample and calculating the protein content by using a conversion factor. Typically, the material is digested using a particular nitrogen determination technique, such as the Kjeldahl technique, which comprises a sequence of chemical reactions to release and transform nitrogen into a measurably detectable form. The nitrogen level is then multiplied by a conversion factor, commonly 6.25, to determine the protein content.

$$\text{Protein Content (\%)} = \frac{(A-B) \text{x} N \text{x} 1.4007 \text{x} 6.25}{W} \qquad (3)$$

2.6 Cooking loss (%)

The samples were cooked, chilled, and then reweighed in accordance with the treatment's specifications (5 minutes) in order to calculate cook loss. Before being reweighed, the samples were removed from the cooking pan and their surfaces were dried using paper towels. The temperature fluctuations in cooked sausage while chilling were also monitored using portable digital thermometers. Items were cooked in the experiment, reweighed, and then left at room temperature for an additional day before being weighed again.

$$\text{Cooking loss\%} = \frac{W_1 - W_2}{W_1} \times 100 \qquad (4)$$

2.7. Process yield (%)

The sausages were cooked for 4 minutes in boiling water, then drained for 10 minutes. By determining the weight difference between the food before and after cooking, the process yield was calculated. The following equation represents the process yield.

$$\text{Process yield (\%)} = \frac{W_1}{W_2} \times 100 \qquad (5)$$

3. Results
3.1. Proximate analysis
The physical and chemical characteristics of the developed sausages are shown in the table. With the lower cooking loss of the treated sausages, process yield of produced sausages was shown to be significantly higher. The increased protein and lower fat content of the sausages may be responsible for their lowered cooking loss. The proportion of fat in meat products has an impact on cooking loss, according to Hong *et al*., (2004) [18]. Higher process yield in developed products may also be related to the increased moisture binding provided by the additional maize starch. This fact and the proximate composition are highly correlated. Sausages with less fat were shown to have higher moisture contents. Similar outcomes were noted by Ali *et al*., (2011) [19] in low-fat beef patties that also contained potato flakes.

Table 2: Project design of treatment

Sample	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}
Boiling time (min)	30.00	25.00	30.00	17.93	20.00	25.00	25.00	25.00	25.00	25.00	20.00	32.07	25.00
Corn starch (%)	25.00	6.89	10.00	17.50	10.00	17.50	28.11	17.50	17.50	17.50	25.00	17.50	17.50
Protein %	10.66	12.76	12.93	9.78	13.28	10.31	10.34	10.31	10.31	10.31	10.83	10.48	10.31
Moisture (%)	51.94	59.13	45.21	61.43	55.44	48.52	60.51	48.52	48.52	48.52	56.29	56.66	48.52
Fat (%)	3.55	3.45	3.65	3.23	3.3	3.16	3.63	3.16	3.16	3.16	2.9	3.39	3.16
Cooking loss (%)	6.53	21.31	14.7	11.97	14.19	14.51	21.81	14.51	14.51	14.51	7.52	15.12	14.51
Process yield(%)	93.46	78.68	85.29	88.02	85.8	85.48	78.18	85.48	85.48	85.48	92.47	84.73	85.48

The moisture content in formulated and developed sausages was significantly higher in T_4 with the amount of 61.43. It might be as a result of the addition of fat substitutes and corn starch's improved capacity to bind water (Berry and Wergin, 1993) [20]. According to Muhlisin *et al*., (2012) [21], the beef patties' moisture levels may have increased as a result of the fat replacement utilising fat replacer.

Table 3: Proximate composition of cooked pork sausages at different level of cooking period and corn starch (%)

Parameters	(%) Composition
Protein content	10.464
Moisture content	55.82
Fat content	3.58
Cooking loss	12.5
Process yield	87.46

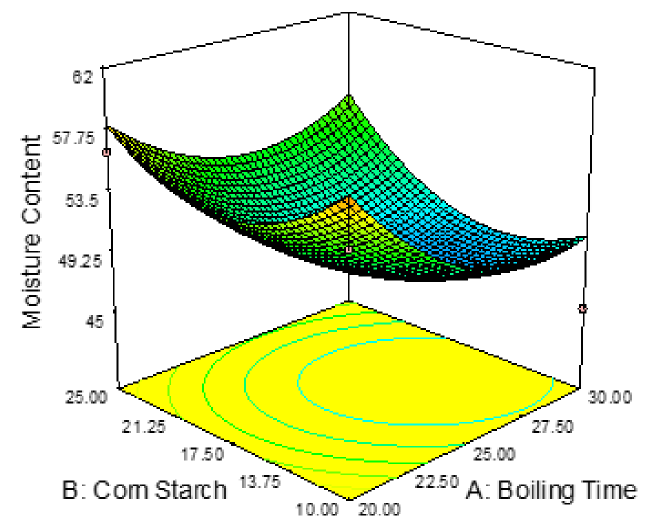

Fig 1.1: Moisture

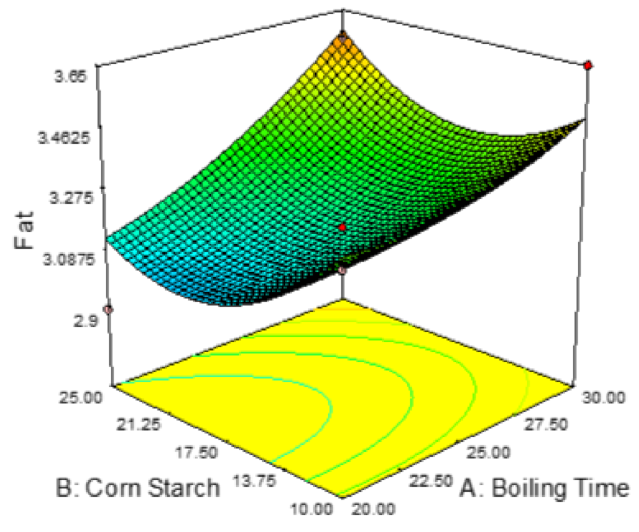

Fig 1.2: Fat content

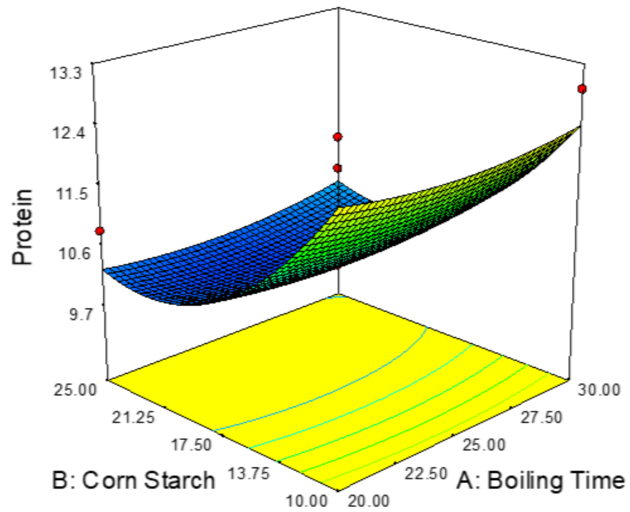

Fig 1.3: Protein

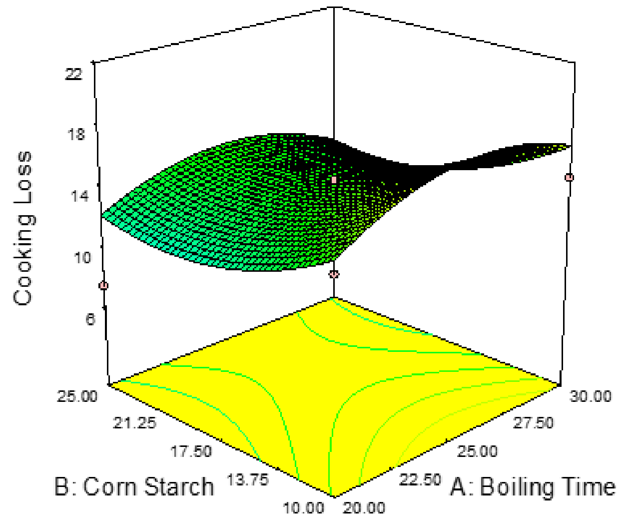

Fig 2.4: Cooking loss

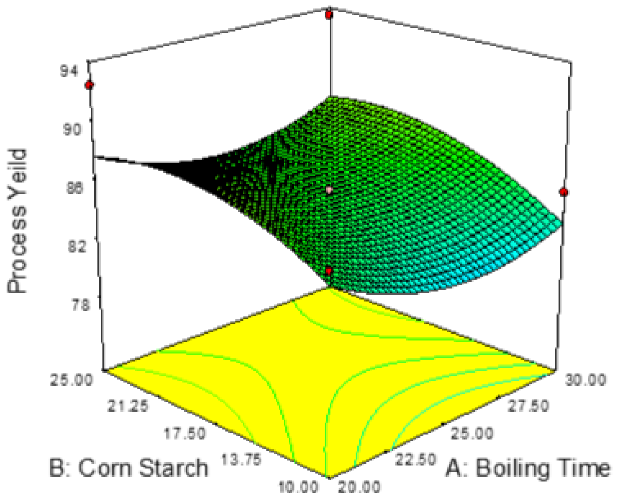

Fig 1.5: Process yield

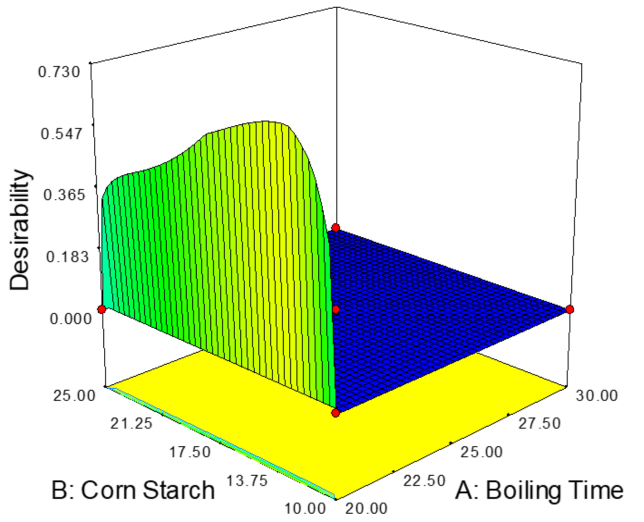

Fig 1.6: Desirability

Fig 1: Response surface plots showing quality attributes dependency on Boiling time and Corn starch.

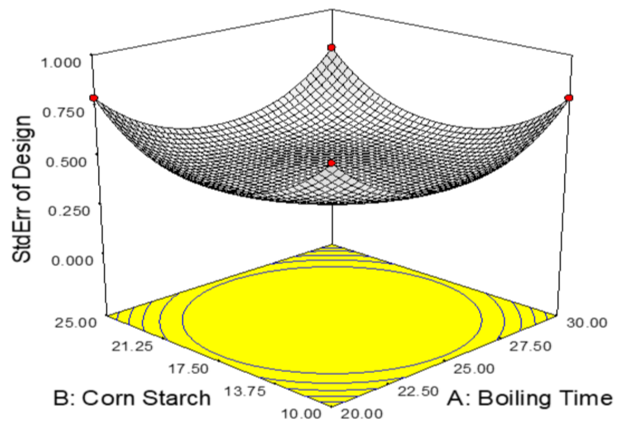

Fig 2: Design Matrix Evaluation for Response Surface Quadratic Model

4. Conclusion

On the basis of general desirability of average values, the sample T_5 was found to be the best among all since it had balanced proximate compositions. 13.28% protein, 55.44% moisture, 3.3% fat, 14.19% cooking loss and 85.8% process yield are all present in this food. It is possible to alter a person's eating habits to enhance their health and avoid micronutrient shortages. More in-depth research is required to determine the benefits of mix starch sausages for health, illness prevention, and antioxidant activity, especially underutilized starch.

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