

Quality Evaluation of Vienna Sausage Incorporated with Sweet Potato Flour and Gelatin Mixture as a Fat Replacer

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Abstract

This study investigated the quality of Vienna sausage with sweet potato flour and gelatin mixture (SFGM) as a fat replacer. Four types of Vienna sausage were prepared with different amounts of SFGM (0, 10, 20, and 30%), and evaluated for physicochemical quality, proximate composition, texture profile analysis, and sensory quality. Addition of SFGM to the sausage increased the cooking loss and moisture ($p \leq 0.05$). Adding an increment of SFGM at 30% significantly decreased the fat content and calorific value of the sausages by 29.65% and 17.45%, respectively. The protein content and textural parameters were not significantly influenced by the quantity of SFMG added ($p > 0.05$). No significant differences were observed for all the sensory likability scores between the control and sausage samples with SFGM. Reduced-fat Vienna sausage with acceptable sensory attributes and lower calories can, therefore, be successfully developed with the incorporation of 30% SFGM.

Keywords: Vienna sausage, sweet potato, gelatin, fat replacer

Introduction

Vienna is one of the most popular emulsion type sausages in Thailand and generally recognized as a good source of protein. However, it has high-fat, high-calories and low fiber content. Therefore, regular consumption of Vienna sausage is associated with health problems including obesity and cardiovascular diseases. This has led to research to reformulate the product and reduce the fat content. Lowering the fat content in meat commodities usually results in reduction of the sensory qualities of the final product, mainly regarding texture and overall acceptance. However, meat products formulated with a lower fat content by the incorporation of fat replacers have been applied successfully using added water [1], plant carbohydrate [2], plant protein [3], animal protein [4], and dietary fibers [5]. These additions resulted in improved physicochemical and sensory properties of the products. The ideal fat replacers for meat products are low-cost and contain nutrients which are deficient in the meat. Sweet potato is rich in carbohydrate, dietary fibers, protein, minerals, and vitamins including ascorbic acid. It is also a good source of β -carotene and has inherent water retention property. Verma *et al.* [2] demonstrated that low-fat pork patties prepared by adding 1% sweet potato powder and 9% water had higher moisture content, better dimensional characteristics and lower calorific values than the control. Gelatin is a denatured protein derived from collagen by thermo-hydrolysis. It serves primarily as a gelling agent in food systems, but is also used as a stabilizer, emulsifier, adhesive agent, foaming agent, protective colloid, and a beverage fining agent. Gelatin consists of different quantities of 18 amino acids with glycine, proline, and hydroxyproline as the most abundant. The most valuable property of gelatin is its ability to form thermo-reversible gels which provide the unique “melt-in-the-mouth” quality [6]. Ching *et al.* [7] reported that incorporation of gelatin into mechanically deboned chicken meat (MDCM) sausages successfully improved the sensory properties and also physicochemical stability during storage.

Although, the addition of sweet potato powder and gelatin have been used to improve the physicochemical and sensory properties of meat products, information on utilizing a combination of sweet potato powder, water, and gelatin is limited. Therefore, the objective of this study was to determine the effect of incorporating sweet potato powder, water, and gelatin mixture (SFGM) as a fat replacer on the physical, chemical, and sensory characteristics of Vienna sausage.

Materials and methods

Preparation of sweet potato powder

Sweet potato tubers were purchased from a local market in Khon Kaen Province, Thailand. After removing the rind and washing with tap water, the tubers were sliced into thin circular shapes (0.5 cm thick), and soaked in 0.5% sodium metabisulfite solution for 30 min. After draining, the thin cuts were dried in a tray dryer at 65°C to reduce the moisture content to 8% or below [2]. The dried sweet potato chunks were then ground with a pin-mil and screened through a 500 µm mesh sieve.

Preparation of the sweet potato powder, water, and gelatin (SFGM) mixture

SFGM was prepared by mixing sweet potato powder, gelatin powder, and distilled water in a 1:0.25:9 ratio [2] using a magnetic stirrer.

Production of Vienna sausage

Four mixtures for Vienna sausage with different amounts of SFGM as a fat replacer (0, 10, 20, and 30%) were prepared, following the procedure reported by Wimontham and Rojanakorn [8] with some modifications. Fresh, boneless pork legs and pork back fat were purchased from a local meat market in Khon Kaen Province. The pork meat was trimmed to remove the separable fat, and the lean meat and partially frozen pork back fat were separately ground through 12 mm and 2.5 mm plates, respectively. The ground meat plus 33% ice was blended in a bowl chopper (cutter M11N, NMH Maschinen, Germany) at low speed for 1 min. The remaining ingredients were added in the order: sodium chloride, sodium tripolyphosphate, sodium ascorbate, and ice. The mixture was chopped at high speed for 2 min, then spices, seasoning, and ice were added and chopped for an additional 2 min. SFGM at 0, 10, 20, and 30%, ground pork fat and the remaining ice were then incorporated as the meat mixtures and further chopped for another 2 min at high speed. The mixtures were chopped for a total of 7 min, and the final temperature of the meat blend was around 12°C. Raw meat batter was then stuffed into a 14 mm diameter Nojak cellulose casing (Viscase SA Bagnold Cedex, France) using a stuffer (TWF-12, DICK, Germany), hand linked at 12 cm intervals and cooked in hot water (80°C) until the core

temperature reached 72°C. The cooked sausages were cooled in water (4°C), and then vacuum packed in PE/Polyester bags and chilled (5±1°C).

Physical and chemical analyses of the sausage samples

The chemical composition of the sausage samples (moisture, fat, protein, and ash) was determined according to AOAC procedures [9]. Carbohydrate was calculated by difference. Total calories (kcal) were calculated for 100 g samples using the Atwater values corresponding to fat (9 kcal g⁻¹), protein (4.02 kcal g⁻¹), and carbohydrates (3.87 kcal g⁻¹) [10].

Cooking loss was determined by weight difference before and after cooking ten Vienna sausage samples from each treatment in hot water (80°C) until the core temperature reached 72°C as per Andres *et al.* [11].

The color of fresh cut cross-sections from all cooked sausage samples (9 per treatment) was measured using a Minolta colorimeter (CR-300, Konica Minolta, Japan) calibrated with a white standard tile, and the results were expressed as L* (lightness), a* (redness), and b* (yellowness).

Texture profile analyses (TPA) of the cooked sausages were determined using texture analyzer (TA-XT2i, Stable Micro Systems, Surrey, UK) according to the method of Wimontham and Rojanakorn [8] with slight modifications. Nine cylindrical slices (each 14 mm diameter, 15 mm long) from each treatment were subjected to a two-cycle compression test using a 25 kg load cell. The samples were compressed to 40% of their original length using a 35 mm diameter probe with a cross-head speed of 2.0 mm/s.

Sensory evaluation of the sausage samples

Sensory analyses were performed by 50 untrained panelists who were asked to evaluate their preferences on color, odor, taste, texture, and overall liking using a 9-point hedonic scale (9 = like extremely, 1 = dislike extremely). Before the test, the Vienna sausage samples were steeped in boiling water in individual pans for 2 min. Warm 2.5 cm long pieces from each formulation were randomly distributed for evaluation. Tap water and unsalted crackers were provided between samples to cleanse the palate as recommended by Deda *et al.* [12].

Statistical analysis

All experiments were conducted in duplicate and the results were presented as means with standard deviations. Analysis of variance and Duncan's new multiple range test were performed to identify differences among the means using SPSS software version 19. Statistical significance was accepted at 95% probability.

Results and Discussion

Variations in the mixtures of sweet potato powder, water, and gelatin (SFGM) significantly affected the color parameters and cooking loss of the sausage samples ($p \leq 0.05$) (Table 1). Increasing the SFGM level increased the yellowness (b^*) and redness (a^*), but decreased the lightness (L^*) of the sausage samples compared to the control ($p \leq 0.05$). This may be due to a non-enzymatic browning reaction between reducing sugars present in the sweet potato powder, and the protein in meat and gelatin during cooking. Verma *et al.* [2] reported that the b^* of low-fat pork burgers increased with increasing sweet potato powder. Sausage samples containing SFGM exhibited higher cooking loss than the control ($p \leq 0.05$) (Table 1). This may result from the extra water in the SFGM. Interestingly, an increment of SFGM from 10% to 30% significantly decreased the cooking loss ($p \leq 0.05$). Results demonstrated that the fiber in sweet potato powder and gelatin in SFGM had water binding capacity. Choe *et al.* [13] reported that the addition of a pork skin and wheat fiber mixture decreased the cooking loss of sausage because of the water binding ability on the wheat fiber and protein content in the pig skin.

Table 1. Effect of sweet potato powder, water, and gelatin mixtures on the color parameters and cooking loss of the sausage samples

SFGM (%)	Property			
	L^*	a^*	b^*	Cooking loss (%)
0 (control)	60.14 ± 0.26 ^a	5.99 ± 0.43 ^b	15.73 ± 0.71 ^d	2.48 ± 0.52 ^d
10	58.02 ± 0.26 ^b	6.33 ± 0.45 ^b	18.00 ± 0.34 ^c	6.38 ± 0.35 ^a
20	56.81 ± 0.61 ^c	6.67 ± 0.27 ^a	18.92 ± 0.25 ^b	5.26 ± 0.48 ^b
30	54.48 ± 0.94 ^d	6.67 ± 0.44 ^a	19.31 ± 0.26 ^a	4.19 ± 0.18 ^c

Means within the same column having different letters were significantly different ($p \leq 0.05$)

The level of SFGM did not affect the textural parameters of the sausage samples ($p > 0.05$) (Table 2), indicating that SFGM can be used as a fat replacer in Vienna sausage production. Table 3 shows that the addition of SFGM increased the moisture content in the sausage ($p \leq 0.05$) because of the water binding capacity of sweet potato fiber and gelatin. As expected, the addition of SFGM at 30% significantly decreased ($p \leq 0.05$) the fat content and calorific value of the samples by 29.65 % and 17.45 %, respectively. Choe *et al.* [13] reported that low-fat frankfurters containing a 20% pork skin and wheat fiber mixture had 50% less fat and 32% fewer calories than the control ($p \leq 0.05$). Verma *et al.* [2] also noted that low-fat pork patties developed with a 1% sweet potato powder and 9% water combination showed reduction in calorific value by 23%. However, the level of SFGM did not influence the protein content of the sausage samples ($p > 0.05$).

Table 2. Effect of sweet potato powder, water, and gelatin mixture on the textural parameters of the sausage samples

SFGM (%)	Hardness (gr)	Cohesiveness	Springiness	Chewiness (gr)
0	3585.60 ± 198.03 ^a	0.67 ± 0.01 ^a	1.05 ± 0.01 ^a	2553.32 ± 175.14 ^a
10	3639.00 ± 305.75 ^a	0.68 ± 0.04 ^a	1.06 ± 0.05 ^a	2412.84 ± 229.07 ^a
20	3765.64 ± 335.98 ^a	0.65 ± 0.00 ^a	1.03 ± 0.06 ^a	2547.76 ± 297.94 ^a
30	3650.80 ± 207.64 ^a	0.67 ± 0.05 ^a	1.04 ± 0.05 ^a	2481.29 ± 228.80 ^a

Means within the same column having different letters were significantly different ($p \leq 0.05$)

Table 3. Effect of sweet potato powder, water, and gelatin mixture on the chemical composition of the sausage samples

SFGM (%)	Moisture (%)	Fat (%)	Protein (%)	Energy (kcal)
0 (control)	60.89 ± 0.07 ^d	18.92 ± 0.16 ^a	13.62 ± 0.05 ^a	237.36 ± 2.89 ^a
10	62.30 ± 0.24 ^c	17.25 ± 0.11 ^b	14.11 ± 0.25 ^a	224.10 ± 0.87 ^b
20	64.19 ± 0.30 ^b	14.10 ± 0.13 ^c	13.93 ± 0.34 ^a	195.77 ± 0.25 ^c
30	65.51 ± 0.12 ^a	13.31 ± 0.15 ^d	13.92 ± 0.27 ^a	195.93 ± 1.01 ^c

Means within the same column having different letters were significantly different ($p \leq 0.05$)

The panelists were asked to evaluate the effect of the level of SFGM on color, odor, taste, texture, and overall likability (Table 4). All the sensory attributes were not significant ($p > 0.05$) for different levels of SFGM. The overall liking scores ranged between 7.07 and 7.27, indicating that all sausage samples were moderately received by the panelists. Therefore, SFGM can be used for fat replacement with no negative effect on the sensory liking scores of Vienna sausage.

Table 4. Effect of added level of sweet potato powder, water, and gelatin mixture on the sensory evaluation of the sausage samples

SFGM (%)	Color	Odor	Texture	Taste	Overall likeability
0 (control)	6.93 ± 1.17 ^a	7.17 ± 0.87 ^a	7.03 ± 1.10 ^a	7.10 ± 0.99 ^a	7.27 ± 0.74 ^a
10	6.90 ± 0.88 ^a	7.10 ± 0.96 ^a	7.03 ± 0.96 ^a	7.20 ± 0.92 ^a	7.23 ± 0.97 ^a
20	6.53 ± 1.14 ^a	7.17 ± 1.02 ^a	7.20 ± 1.19 ^a	6.87 ± 1.28 ^a	7.27 ± 0.94 ^a
30	6.60 ± 1.35 ^a	7.20 ± 0.92 ^a	6.83 ± 1.21 ^a	6.90 ± 1.16 ^a	7.07 ± 0.87 ^a

Means within the same column having different letters were significantly different ($p \leq 0.05$)

Conclusions

The addition of a sweet potato, gelatin, and water mixture (SFGM) increased the moisture content and cooking loss of the sausage samples. The fat content and calorific values decreased with increasing SFGM. However, the level of SFGM did not affect the textural parameters of the sausage samples. The results of sensory evaluation, calorific values, and textural parameters indicated that up to 30% SFGM can be used as a fat replacer for Vienna sausage production without serious detrimental effects on sausage quality.

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