Effect of Banana Peel Flour Incorporation (*Musa acuminata*) on Physicochemical and Sensory Profile of Chicken Sausage

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ABSTRACT The study was conducted to determine the physicochemical and sensory properties of chicken sausages added with banana peel flour (BPF) in different percentages of BPF (2%, 4% and 6%). The use of BPF in sausage formulations did have a significant effect ($P < 0.05$) on the proximate compositions, dietary fibre and mineral content of the sausages. By increasing the proportion of BPF in the sausage 4 to 6%, the hardness was increased by 31% and 54% respectively ($P < 0.05$). The darker sausage was obtained as more BPF added in the formulation. The sensory evaluation showed that the chicken sausage with a concentration of 2% had the highest overall acceptability. In comparison, a sausage containing 6% was found to be the least acceptable compared to the control sample. The declining sensory acceptability of the sausages with 6% BPF was related to its hard texture and dark colour.

KEYWORDS: Banana peel, dietary fibre, meat product, sausage, physicochemical properties, sensory properties
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INTRODUCTION

In recent years, urbanization and socioeconomic factors have increased the consumer's preference for ready to eat foods as well as to pursue healthier dietary habits. In meat product manufacture, this has caused the industry to come under heavy pressure, because of the demand to come up with products which are free of harmful constituents. These constituents should be either eliminated or reduced within appropriate limits. Also, the incorporation of bioactivities of compounds originally present in plants in meat products has been a great deal of interest worldwide. In this aspect, dietary fibre (DF) is a component which can be incorporated in meat products as there is a need to increase the intake of dietary fibre. The overconsumption of meat and meat products increases the risks of several diseases, such as colon cancer, cardiovascular diseases, and obesity. Hence, available documentary evidence supports the notion that the intake of fibre diminishes the threat of such diseases (Yadav *et al*., 2016). Adding DF to a food product improves not only nutritional and health properties, but also confers technological properties such as enhancing water holding capacity and rheological properties, reducing costs for the formulation, and enhancing the texture in meat products (Mehta *et al*., 2015).

Banana is one of the world's most consumed and affordable fruit which has been extensively cultivated in most tropical countries. There are many varieties of banana which can be accessible in the local markets found across Malaysia. One of the most popular variety is the Berangan (*Musa acuminate* Colla (*M. acuminata*) AAA cv Berangan) banana. Generally, banana peels represent 40% of the total weight of the fresh fruit and are primarily used as an agricultural residue in the banana processing industry (Rasidek *et al*., 2015). The immense amounts of by-products are an excellent source of highly valuable compounds for other sectors. In terms of nutritional composition, it is well known that the banana peel contains a vast quantity of dietary fibres, mainly pectin and hemicellulose compounds, complex polysaccharides which are often present in fruits and some root vegetables. In this context, the banana peel offers considerable potential for the development of fibre enriched meat products.

A few research on the food products fortified with banana peel have been published, such as flatbread (chapatti) (Kurhade *et al*., 2016), alkaline noodles (Ramli *et al*., 2009), cookies (Agama-Acevedo *et al*., 2016) and gluten-free cakes (Türker *et al*., 2016). There is, however, a lack of documented studies on the use of banana peel flour (BPF) in meat product development. Therefore, this study was carried out to evaluate the effects of BPF on the physicochemical and sensory properties of chicken sausage.

METHODOLOGY

Banana Peel Flour (BPF) Preparation

The raw material was prepared from ripe banana (*Musa acuminata*) peels in stage 7 of ripening (yellow with brown dots, without the visible presence of microbial proliferation) which is collected from the local market of Kota Kinabalu, Sabah, Malaysia. The overripe bananas were washed with tap water; peels were separated from its flesh and immersed in 0.5% (w/v) citric acid solution for 30 minutes to reduce the enzymatic browning (Arquelau *et al*., 2019). It was then drained, dehydrated in drying cabinet (Thermolite, Malaysia) at 40^{o}C for 48 hours and dried peels were ground to pass through 60 mesh. The produced banana peel flour was stored inside airtight plastic packs in cold storage (15±2 ^{o}C) until analysis.

Chicken Sausage Preparation

Fresh deboned chicken breasts were obtained from the company Desa Hatchery Sdn. Bhd., Lok Kawi, Sabah, Malaysia. The obtained meat was minced in an electrical mincer. For the preparation of the control sausage samples, ice water (14.90%), chicken fat (10%), isolated soy protein (5%), sodium chloride (1.5%), potato starch (3%), sugar (0.5%), seasoning (0.05%) and white pepper (0.05) were added to minced meat (65%). The treatment consisted of an addition of BPF at three different compositions, which were 2%, 4% and 6%. The other ingredients remained unchanged.

Minced chicken meat along with other ingredients and BPF were mixed in a mixer (*Hobart*, VCB61, Italy) for 3 minutes to prepare a stable emulsion. The emulsion was then stuffed in an artificial cellulose casing by hand-operated sausage filling equipment and precooked in a water bath at 75±2 ^{o}C for 30 minutes. After cooking, the sausages were cooled in water (15 ^{o}C) for 20 minutes, drained, packaged in airtight plastic bags, and stored at refrigerated temperatures for further studies.

Proximate, Total Dietary Fibre (TDF) and Mineral Content Analysis

Standard procedures were used to determine proximate composition (AOAC, 2000) and total dietary fibre (TDF) (AOAC, 2005) of controlled and treated sausages. Mineral content analysis was conducted in accordance with Hseu (2004) procedure.

Instrumental Texture and Colour

The texture profile analysis (TPA) was performed as per the procedure outlined by (Hu *et al*., 2016) using TA.XT Plus Texture Analyzer (Stable Micro System, Surrey, UK). Samples of 25 mm in diameter and 20 mm in height were compressed to half (50%) of their original height using a cylinder probe (P/75). A time of 5 seconds was allowed between the two compression cycles with a crosshead speed of 2 mm/s. Textural attributes such as hardness (N), cohesiveness and chewiness (N x mm) were analysed. Subsequently, the colour of the sausage was measured using a Konica Minolta Chroma Meter CR-400 (Konica Minolta Sensing, Inc., Japan) as per the procedure outlined by (Choe *et al*., 2018). The colour scores were expressed as CIE Lab L* (lightness), a* (redness) and b* (yellowness).

Sensory Profiling

The sensory evaluation was carried out by 50 untrained students from the Faculty of Food Science and Nutrition, Universiti Malaysia Sabah. Sausage samples which were of 2.5 cm in diameter and 2 cm in thickness were cut, coded, and presented in a randomised order to the panel members individually. They were then asked to evaluate the samples for sensory attributes, appearance, aroma, taste, colour, hardness, juiciness, and overall acceptability using the seven-point hedonic scale (1 = extremely undesirable, 7 = extremely desirable). Filtered tap water was provided to rinse the mouth between sample testing.

Statistical Analysis

The obtained data from three replicates were subjected to a one way. Duncan's multiple-range was used to determine the significant difference in the mean values. The critical difference was determined at 5% level of significance.

RESULT AND DISCUSSION

Proximate and Total Dietary Fibre Content

The proximate composition and TDF of the sausages with the addition of BPF at different concentrations are reported in Table 1. The dietary fibre is known for its ability to hold water. However, the moisture content of the chicken sausages declined significantly ($p<0.05$) after the addition of BPF to the sausages.

Table 1. Proximate Composition and Total Dietary Fibre (TDF) of Chicken Sausage

Treatment	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	TDF (%)
Control	70.62±0.34[a]	13.73±0.29[a]	9.18±0.75[a]	3.04±1.20[c]	0.83±0.70[b]
BPF2[a]	69.25±0.12[ab]	11.03±0.15[b]	8.43±0.47[ab]	3.99±0.34[bc]	0.86±1.13[ab]
BPF4	68.11±0.64[bc]	9.74±0.49[c]	8.69±1.03[ab]	4.26±0.12[abc]	1.90±0.42[a]
BPF6	67.44±0.27[bc]	8.41±0.74[d]	7.86±0.50[b]	5.19±0.34[ab]	-

[a]BPF2: sausages with 2% BPF; BPF4: sausage with 4% BPF; BPF6: sausage with 6% BPF

The reduction of moisture content in the sausage, which was added with BPF could be explained by the lower moisture content of the BPF itself, due to the drying process (Yadav *et al*., 2018). According to Yadav *et al*. (2016), the utilisation of dietary fibres in the dried form has been reported to decrease the moisture levels of the meat product. A previous study by Talukder & Sharma (2010) also found that the addition of 15% wheat bran in chicken meat patties resulted in a decrease in moisture content (59.80%) compared to the control sausage sample (62.60%). Protein content decreased significantly ($p<0.05$) in BPF-treated sausages in comparison to the control. This could be explained due to less protein content in BPF in comparison to meat (Yadav *et al*., 2018). Studies by Yadav *et al*. (2016) also reported that the reduction of protein content in chicken sausages incorporated with corn barn, dried apple pomace and dried tomato pomace. The fat content of the sausages remained unaltered after the fibre incorporation at 2% and 4% ($p>0.05$) but reduced significantly ($p<0.05$) with the addition of 6% BPF. High DF content presence in BPP also resulted in an increase of the DF content in BPF-treated sausages in comparison to the control ($p<0.05$). Following the study by Huda *et al*. (2010), the proximate contents of all the formulations from this study are in normal range with Malaysian commercial sausages, except for the enhanced ash content in BPF2, BPF4, and BPF6.

Mineral Content

Table 2 present the mineral content of chicken sausage incorporated with BPF. Overall, there are significant increase in mineral element, namely calcium, magnesium, iron, potassium, and zinc. This demonstrated that the banana peel could be a good source of the mentioned mineral element. Potassium, which is the highest mineral presence in the treated sausages is essential element aid in body and muscle development. There are scarce data on the mineral content of Malaysian commercial chicken sausages. However, the range of Ca in extended products lower than Huda *et al.* (2010), of which the range of Ca content in the Malaysian commercial chicken sausages ranged from score 0.27 - 1.16 mg/g. The difference in these results is primarily due to the type of meat used (mechanically deboned meat or conventional hand deboned meat) and the ingredients used in sausage making.

Table 2: Mineral Content in Chicken Sausage Incorporated with BPF

	Macro element (mg/Kg)				Micro element(mg/Kg)	
Treatment	Ca	Mg	Fe	K	Mn	Zn
Control	109.75±0.35^d	200.50±0.71^c	8.50±0.00^c	2511.75±23.69^d	1.00±0.00^a	8.50±0.00^d
BPF2[a]	120.00±0.71^c	203.00±0.71^{cb}	8.50±0.00^c	2989.50±59.40^c	2.00±0.00^a	9.50±0.00^c
BPF4	167.25±1.06^b	209.25±1.78^b	11.50±0.00^b	3235.00±76.37^b	3.00±0.00^a	13.50±0.00^b
BPF6	182.75±0.35^a	226.75±0.35^a	15.00±0.00^a	3832.00±49.50^a	3.50±0.00^a	14.75±0.35^a

[a]BPF2: sausages with 2% BPF; BPF4: sausages with 4% BPF; BPF6: sausage with 6% BPF

Instrumental Texture and Colour

Analysis of texture profile of all sausage formulations showed that BPF-treated sausages were harder than control sausage (Table 3). Several authors reported miscellaneous results obtained on textural properties of meat products incorporated with fibre. This varied result might be due to difference in their source, type (soluble/insoluble), concentration and processing method of fibre (fresh/dried) (Yadav *et al*., 2018). Generally, hardness is greater when fibre was included in a meat emulsion because of the immobilisation of water and trapped fat in the fibre network (Meija *et al*., 2019). This obtained result from all formulations was within the range of textural properties obtained from several Malaysian commercial chicken sausages (Huda *et al*., 2010). Cohesiveness scores of BPF-treated sausages show no significant different ($p>0.05$). Cohesiveness and chewiness are dependant parameters, and their scores depend on the score of hardness.

Table 3. Instrumental texture and colour properties of sausage formulations

	Texture			Colour		
Treatment	Hardness (N)	Cohesiveness	Chewiness (N x mm)	L*	a*	b*
Control	46.60±10.60^c	0.64±0.56^a	18.07±4.06^b	73.48±0.29^a	1.13±0.76^d	13.40±0.14^a
BPF2[a]	55.48±3.90^{bc}	0.62±0.03^{ab}	28.66±1.26^a	63.40±0.36^b	1.59±0.10^c	12.74±0.60^{ab}
BPF4	60.82±8.65^b	0.59±0.08^{ab}	29.57±4.32^a	60.20±0.31^c	2.14±0.07^b	11.97±0.85^b
BPF6	71.91±5.36^s	0.55±0.04^{abc}	34.24±3.39^a	58.07±0.61^d	2.40±0.17^a	11.09±0.04^c

[a]BPF2: sausages with 2% BPF; BPF4: sausages with 4% BPF; BPF6: sausage with 6% BPF

Presence of BPF influenced the colour of chicken sausages significantly ($p<0.05$). Lightness scores of chicken sausages decreased progressively as the concentration of BPF added increased. The darker colour of treated sausage could be linked with the polyphenol oxidase enzyme activity during the drying of banana peel process, which results in browning (Aziz & Al-Sa'ady, 2016). However, the colour range obtained was still in within the range of Malaysian commercial chicken sausage colour (Huda *et al*., 2010).

Sensory Profiling

Appearance attributes showed no significant difference until the concentration of the BPP added was up to 6%, which declined the panellist acceptability score. The colour score increased with the addition of 2% BPF but progressively decreased as the concentration was raised. This indicated that the BPF incorporation provided much better colour scores for the chicken sausages. However, the addition of BPF above 2% decreased the colour scores. Higher colour scores in BPF2 might be because BPF provided a desirable red shade for the chicken sausages. As shown in data obtained from Table 3, the incorporation of BPF does increase the redness (a*) of the sample. However, the addition of BPF resulted in a decline in the aroma and taste attributes ($p<0.05$). In terms of hardness and juiciness, a significant increase was noticed with the addition of 2% BPF, but this declined progressively when the concentration of BPF was raised.

Table 4. Sensory score of sausage formulations.

Treatment	Appearance	Colour	Aroma	Taste	Hardness	Juiciness	Overall acceptability
Control	4.78 ± 1.23^{a}	4.46 ± 1.53^{ab}	5.21 ± 1.07^{a}	5.15 ± 1.49^{a}	3.73 ± 1.85^{c}	3.93 ± 1.80^{b}	4.64 ± 1.19^{bc}
BPF2[a]	4.80 ± 1.08^{a}	4.87 ± 1.52^{a}	4.70 ± 1.32^{b}	5.05 ± 1.41^{a}	5.11 ± 1.24^{a}	4.76 ± 1.78^{a}	5.26 ± 1.40^{a}
BPF4	4.64 ± 1.22^{a}	3.98 ± 1.30^{b}	4.67 ± 0.89^{b}	4.90 ± 1.33^{a}	4.82 ± 1.13^{a}	4.91 ± 1.11^{a}	5.02 ± 1.08^{ab}
BPF6	3.94 ± 1.44^{b}	3.07 ± 0.99^{c}	3.75 ± 0.48^{c}	3.98 ± 0.93^{b}	4.16 ± 1.22^{bc}	3.91 ± 1.06^{b}	4.16 ± 0.96^{c}

[a]BPF2: sausages with 2% BPF; BPF4: sausages with 4% BPF; BPF6: sausage with 6% BPF

CONCLUSION

Dietary fibre enriched chicken sausages prepared at 2% BPF were organoleptically acceptable compared to other samples. However, the addition of BPF in chicken sausages resulted in the deterioration of its hardness and cohesive texture. Besides, as well as improving the texture properties at low level, the BPF also provided health benefits such as an increase in the dietary fibre and mineral content of the product. In particular, optimisation of the flour preparation conditions warrants further investigation. The results suggest that banana peel powder can be an inexpensive dietary fibre source. It can be incorporated into meat products due to the beneficial effects which have been seen in terms of nutritional composition and enhancement of the functional properties.

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