The Haryana Veterinarian (December, 2023) **62(2),** 72-77 ISSN 0033-4359 (P) **Research Article**

TECHNOLOGICAL EFFECT OF DRIED APPLE PULP POWDER ON THE QUALITY CHARACTERISTICS OF FUNCTIONAL PORK SAUSAGES

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ABSTRACT

Present study was performed to develop functional pork sausages by incorporating apple pulp as a source of fibre. Functional pork sausages were prepared after the incorporation of dried apple pulp powder with the intention of boosting dietary fibre intake through consumption. In pork sausages different quantities of dried apple pulp (3%, 6%, 9%) were added. Adding dried apple pulp powder lowered pH content in all samples. With the increase, emulsion stability and cooking yield was increased. Except for differences in hardness, the sausages retained good textural quality. A higher concentration of apple pulp incorporation at 9% level led to development of a mild sweet flavor in the treatment. Apple pulp powder may be used at a rate of 6 percent (w/w) for the development of high fibre sausage without affecting the sensory attributes significantly.

Keywords: Acceptability, Apple pulp, Pork sausages, Sensory and texture

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Dietary fibre (DF) is widely employed in many sections of the food industry, including the meat sector, due to their beneficial characteristics. Also the incorporation of dietary fibre has been demonstrated to improve cooking yield, water holding capacity, fat binding, and texture enhancement in meat products. Fruit processing companies have seen significant growth in recent decades as a result of changing lifestyles and the desire for ready to eat meat products Apple pulp is an important byproduct of the apple processing industry due to presence of high-quality dietary fibre.

Dietary fibers, which have long been added in many comminute meat products, have also been linked to reducing the incidences of cancers. Although it is thought to shorten the time faecal matter spends in the gut (Burkitt *et al.*, 1972) reduced the time it takes for a response to proliferate. And also bind minerals, lowering haem activity in the colon (Macagnan *et al.*, 2016). According to Soliman *et al.* (2019), DF can lower the risk of cardiovascular disease. It is because of short chain fatty acids produced by DF fermentation which raise the level of acidification in the colon cavity, whereas a low pH can decrease the solubilisation of free bile acids and their transition to secondary bile acids, resulting in increased bile excretion.

2.3 MMT (million metric tonnes) apples were produced in 2021. Fruit by-products from apple, citrus fruits, papaya, watermelon, and other tropical fruits are particularly high in pectin and have commercial potential. One such dietary fibre include apple by-products like apple peel and apple pomace. After the juice/pulp extraction process, the solid wastes (apple pomace) makes up 40% of the raw material. Fresh apple pomace spoils quickly, so it must be dried and preserved if it is to be stored and used for an extended period. The main reason for its use as a thickener and stabiliser and in the food industry as a gelling agent in jams, confectionery and bakery fillings, as well as a stabiliser in yoghurts and milk drinks, due to its excellent water-binding and gel-forming properties even at low concentrations and dietary fiber in food products.

Apart from improving nutritional value, sources of fibers can also improve various technical and functional properties such as cooking yield, emulsion stability, fat binding property, and sensory quality (Talukder, 2015). Younis and Ahmad (2018) and Rosell *et al.* (2009) have shown promising results by incorporating the apple pomace in meat products concerning functional properties like water holding capacity, fat replacers & bulking agents. Considering these facts, the present study was planned to utilize the by-product of fruit processing industry i.e. apple pulp powder as a source of dietary fibre and to study its effect on functional properties and quality parameters of pork sausages.

MATERIALS AND METHODS

Preparation of apple pulp powder

Apples were purchased from local market of Ludhiana (Punjab), After juice extraction, the apple pulp was dried in a vacuum oven (Promarks Vac Co Ltd, Taiwan) at 60º C till constant weight. To obtain the fine powder, the dried apple pulp was crushed in a mixer-grinder and sieved through a stainless steel sieve of 50-60 mesh size. The dried apple pulp powder was put in a plastic

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jar and kept at refrigeration temperature until usage.

Preparation of the pork sausages

Deboned lean pork meat (Chilled) Cut into small chunks

↓

Minced through 6 mm plate

↓

Addition of salt, sugar, nitrite, TSPP (Tetra sodium pyrophosphate) Manual mixing

↓

Addition of pork fat and vegetable oil Chopping (1 min.)

↓

Addition of whole egg liquid, condiments, spices, fiber source (dried apple pomace) etc.

↓

Chopping (2 min.)

↓

Emulsion stuffing in hydraulic sausage filler

↓

Filling into goat casings

↓

Manual linking

↓

Cooking (Internal core temperature 80±2ºC)

↓

Final cooked product

↓

Cooling and delinking, Packaging

↓

Storage (4±1ºC)

Based on several preliminary trials, three different levels of apple pomace viz. 3%, 6%, 9% and control were prepared. Four groups of pork emulsions control (C) and treatments (T1), (T2) and (T3) were prepared by replacing lean form in the formulation (Table 1).

Physico-chemical parameters

pH

The pH of pork sausages (n=6) was determined using a digital pH metre (SAB 5000, LABINDIA, Mumbai) with a coupled glass rod (Trout *et al.*, 1992). In a homogenizer, ten grams of samples were homogenised for one minute with 50 ml distilled water (T-25D S22 digital ultra-TURRAX Germany). A combination glass electrode was dipped into the suspension to record the pH.

Emulsion stability

Twenty gram meat emulsion was placed in 150 gauge low-density polyethylene (LDPE) bags (size 11×10 cm) and heated to 80±1°C for 20 minutes in a thermostatically controlled water bath (Model: NSW 125). The bags were then removed from the water bath, the cooked out liquid (fat, water-soluble solids) was drained, and the weight of the cooked bulk was recorded. The cooked emulsion was weighed and the percentage was calculated (Baliga and Madaiach, 1970).

Cooking yield

The weight of each product was recorded before and after cooking. The cooking yield was calculated and expressed as a percentage by a formula

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked product}}{\text{Weight of raw pork emulsion}} \times 100$$

Instrumental texture profile analysis

A texture analyzer was used to perform instrumental texture profile analysis (TPA) (TMS-PRO, Food Technology Corporation, USA). A sample size of 1.0 cm×1.0 cm×1.0 cm was subjected to a double compression cycle with a load cell of 2500 N at pre-test speed (30 mm/sec), post-test speed (100 mm/sec), and test speed (100 mm/sec).

Sensory evaluation

A panel of seven experienced individuals, consisting of teachers and postgraduate students from College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana evaluated the samples for appearance and colour, texture, flavour, juiciness, and general acceptability by using an 8-point descriptive scale (Keeton, 1983), where 8=extremely favourable and 1=extremely disagreeable. The items were warmed in a microwave oven for 20 seconds before being served to the sensory Odour and Overall acceptability evaluation.

Statistical analysis

The significance level was calculated using a 95% confidence level. Standard statistical methods were used to analyse the data using IBM SPSS Statistics -20.0 software from the United States (Snedecor and Cochran, 1994). For each parameter, duplicate samples were drawn and reproduced three times (n=6). A panel of seven judges conducted sensory evaluations, with a total of 21 observations (n=21). Duncan's multiple range test was used to analyse the statistical significance at the 5% level ($p<0.05$). The outcomes were revealed in the form of Mean± S.E.

RESULTS AND DISCUSSION

Physicochemical properties

Table 2 represents the physicochemical parameters of pork sausages consisting various concentrations of dried apple pulp. The pork sausages with 9% dried apple pulp (DAP) inclusion had a lower mean pH than the control ($P<0.05$). The pH of pork sausages ranged from 5.86 to 5.60. The pH of the product was further reduced in treatments with increasing levels of DAP inclusion, which could be attributable to the acidic character of the apple pulp (pH: 4.65) and pectin, a significant fibre element in apples (pH: 3.1-3.6) (Narasimman and Sethuraman, 2016). Verma and Benarjee (2010) also found that adding apple pulp to low-fat chicken nuggets caused a significant drop in pH. Devatkal *et al.* (2010) also found a decrease in the pH after adding kinnow rind powder as a source of fiber in goat meat patties. Masoodi *et al.* (2002) observed that cake batter with added apple pomace as a source of dietary fibre has a lower pH than control samples attributable to the organic acid content in the apple pomace.

Table 1. Formulations of high-fibre pork sausages

Ingredients %	Control (C)	T1	T2	T3
Minced Pork	70	67	64	61
Dried Apple pulp powder	-	03	06	09
Vegetable oil	5.0	5.0	5.0	5.0
Fat	5.0	5.0	5.0	5.0
Cold water	8.0	8.0	8.0	8.0
Egg liquid	2.0	2.0	2.0	2.0
Salt	1.60	1.60	1.60	1.60
Polyphosphates	0.20	0.20	0.20	0.20
Condiments	3.0	3.0	3.0	3.0
Spices	2.0	2.0	2.0	2.0
Wheat flour	3.0	3.0	3.0	3.0
Sodium nitrite	120 ppm	120 ppm	120 ppm	120 ppm
Sugar	0.20	0.20	0.20	0.20

DAP- Dried apple pulp powder, T1 (3% DAP), T2 (6% DAP) and T3 (9% DAP)

Cooking yield increased as the amount of DAP increased; when compared to the control, T3 had a significantly ($P<0.05$) higher cooking yield as compared to control. This could be owing to the ability of non-meat ingredients to bind water, as well as the gel-forming ability of pectin found in apple pulp (Sharefiabadi *et al.*, 2021). These findings are also in line with those of Malav *et al.* (2015) who found that increasing the amount of cabbage powder in mutton patties increased emulsion stability and cooking yield. Similar findings were also observed in pork patties with sweet potato powder, which attributed to the

Table 2. Effect of incorporation of different levels of dried apple pulp on physico-chemical properties and textural profile analysis of pork sausages (Mean ±S.E)*

Parameters	Physico-chemical properties			
	Control	T1 (3% DAP)	T2 (6% DAP)	T3 (9% DAP)
pH	5.86 ± 0.021^{a}	5.76 ± 0.012^{b}	5.70 ± 0.021^{c}	5.60 ± 0.013^{d}
Emulsion stability	92.63 ± 0.22^{d}	94.54 ± 0.38^{c}	96.46 ± 0.41^{b}	97.44 ± 0.52^{a}
Cooking Yield (%)	91.49 ± 0.67^{d}	93.42 ± 0.36^{c}	94.56 ± 0.46^{b}	95.67 ± 0.44^{a}
		Texture profile analysis		
Hardness (N/cm^2)	31.42 ± 0.16^{a}	30.23 ± 0.11^{b}	29.49 ± 0.16^{c}	28.32 ± 0.19^{d}
Stringiness (mm)	19.86 ± 0.11^{a}	19.49 ± 0.05^{b}	19.38 ± 0.04^{c}	18.85 ± 0.17^{d}
Springiness (cm/mm)	11.41 ± 0.11^{d}	11.85 ± 0.18^{c}	12.30 ± 0.15^{b}	13.71 ± 0.13^{a}
Gumminess (N/cm^2)	6.80 ± 0.08^{d}	7.11 ± 0.01^{c}	7.41 ± 0.02^{b}	7.62 ± 0.05^{a}
Chewiness (N/cm)	41.69 ± 0.22^{a}	40.13 ± 0.19^{b}	38.14 ± 0.21^{c}	36.59 ± 0.27^{d}
Resilience	0.83±0.06	0.80±0.03	0.79±0.06	0.79±0.01

n=6; C= Control; T-1= 3% dried apple pulp; T-2= 6% dried apple pulp; T-3= 9% dried apple pulp. *Mean ±S.E with different superscripts differ ($P<0.05$) significantly.

Table 3. Effect of incorporation of different levels of dried apple pulp on sensory evaluation of pork Sausages (Mean±S.E)*

Parameters	Sensory evaluation			
	Control	T1 (3% DAP)	T2 (6% DAP)	T3 (9% DAP)
Appearance	7.50 ± 0.07^{a}	7.48 ± 0.10^{a}	7.36 ± 0.10^{a}	6.84 ± 0.09^{b}
Flavour	7.48 ± 0.08^{a}	7.41 ± 0.05^{a}	7.35 ± 0.08^{a}	6.69 ± 0.07^{b}
Juiciness	7.43 ± 0.05^{a}	7.38 ± 0.05^{a}	7.35 ± 0.06^{a}	6.57 ± 0.09^{b}
Texture	7.50 ± 0.06^{a}	7.45 ± 0.07^{a}	7.32 ± 0.08^{b}	6.88 ± 0.09^{c}
Overall Acceptability	7.47 ± 0.05^{a}	7.40 ± 0.09^{a}	7.36 ± 0.07^{a}	6.54 ± 0.06^{b}

*Mean±SE with different superscripts differ significantly ($P<0.05$). n=21; C= control; T-1= 3% dried apple pulp, T-2= 6% dried apple pulp; T-3= 9% dried apple pulp. Means are scores given by sensory panellists on an 8-point Hedonic scale were 1: extremely poor and 8: extremely desirable.

development of a stable protein-starch solid lattice structure, which prevented water and fat loss from the patties during cooking (Verma *et al.*, 2015).

As depicted in Table 2 emulsion stability was observed significantly (P<0.05) lower in control as compared to T1 and T2 and the highest emulsion stability was found in T3. The retention of water and fat by fibre (pectin) contained in dried apple pulp may explain the higher emulsion stability of treatment products observed in this study. Furthermore, owing to the presence of hydrogen bonds and the free binding energy, Ahmad *et al.* (2020) found that pectin fibre has a good bond with meat proteins, resulting in a stable emulsion. Similar results have been also reported by Yadav *et al.* (2016) in fiber enriched chicken sausages by Choi *et al.* (2016) in reduced fat at chicken sausages and Younis and Ahmad (2015) in buffalo meat sausage. The inclusion of fibre from various sources increased cooking yield, water holding capacity, and emulsion stability in all of these studies.

Textural profile analysis

A texture profile study of the pork sausages enriched with dried apple pulp at three different levels i.e. 3%, 6% and 9% was carried out and compared with control. The results are summarised in Table 2.

With increasing levels of dried apple pulp incorporation, the hardness value of pork sausages showed decreasing trend. Hardness value was recorded significantly (P< 0.05) lower in T3 than control and other treated products, When higher amounts of dried apple pulp were added to pork sausages, the hardness value of the pork sausages decreases significantly (P<0.05), with T3 having the lowest hardness values. The relatively soft texture of apple pulp may account for the lower hardness values among treatment products, so the lower hardness ratings among treatment products could be attributable to this. According to Verma *et al.* (2010) low-fat chicken nuggets with 8% to 12% (w/w) apple pomace showed a similar decrease in hardness. Decreased hardness was also reported by Jung *et al.* (2015) in fortified chicken patties with the incorporation of 10% and 20% of apple pomace as a meat replacer. Garcia *et al.* (2002) and Lin and Lin (2004) found similar results in low fat dry fermented sausages and chinese style meatballs, with the incorporation of fruit fiber (peach, apple and orange) and bacterial cellulose (Nata), respectively.

Springiness refers to a product's capacity to restore its shape after being deformed during a compression cycle (Texture Technologies, 2003). Springiness was higher among treatment products and was found significantly (P <0.05) higher in T3 as compared to control and it was found lowest in control. These findings were in agreement with Garcia *et al.* (2002) who found a significantly (P<0.05) increase in springiness value in low fat dry fermented sausages incorporating apple and peach fruit dietary fibres.

Table 2 depicted that gumminess increases as the level of dried apple pulp inclusion increases in the treatment product. Among treated sausages, T3 exhibited a significantly (P<0.05) higher gumminess value than control however chewiness of the treated product falls significantly (P<0.05) as the amount of dried apple pulp increases this could be related to lower hardness value as well as soft texture of apple pulp. Similar findings were also reported by Garcia *et al.* (2002) and Lin and Lin (2004) in low fat dry fermented sausages and traditional Chinese meatballs, respectively.

Chewiness values for control were significantly higher (P<0.05) when compared to treatment and it was recorded lowest in T3 which can be correlated with the lower value of the hardness on inclusion of apple pulp at a higher level. Low fat dry fermented sausages incorporating inulin as a fat alternative and source of soluble dietary fibre showed a decreasing trend in gumminess and chewiness, (Mendoza *et al.*, 2001). The findings resembled those of Sánchez -Zapata *et al.* (2010) in a pork burger supplemented with tiger nut fibre.

Treatments with 3%, 6% and 9% dried apple pulp had significantly higher (P <0.05) cohesiveness and gumminess values in comparison to control. In comparison to control, Naveena *et al.* (2006) found that by replacing dry wet apple pomace by chicken patties significantly reduced hardness, springiness, cohesiveness, and chewiness.

Sensory evaluation

The scores of all the sensory parameters (appearance, flavour, juiciness, texture and overall acceptability) for pork sausages incorporated with three different levels of dried apple pulp *viz.* 3%, 6% and 9% are presented in Table 3. Sensory scores for all the sensory attributes of pork sausages varied significantly (P<0.05) with the addition of different levels of dried apple pulp.

Colour and appearance scores decreased with the increase in dried apple pulp level in the product, T3 had the lower value. These results are consistent with the data collected by the chromo colour metre. Significant (P<0.05) decrease was noticed in 9% DAP treated sausages, whereas T1 and T2 were comparable to control. A comparable general appearance between control and T1 and T2 could be attributed to the attractive oxidised red colour of the apple pulp. Significantly (P<0.05) lower colour and appearance scores were recorded in T3 which might be due to the dark colour appearance of the pork sausages as a result of cooking. Lopez-Vergas *et al.* (2014) found a similar result in pork burgers that had albedo fibre powder added to them.

Flavour scores decreased significantly (P<0.05) as the amount of dried apple pulp was increased when compared to control. T3 had lower flavour scores among treatment products. This could be due to mild fruity flavour and dilution of meaty flavour attributed by apple pulp inclusion at higher levels. Similar results were recorded by Verma and Banerjee (2010) with the inclusion of apple pulp in the low-fat chicken nuggets. Mean flavour scores for T2 were comparable with control and T1. Among the treatments, the sensory panellists awarded a minimum score for the flavour to T3 and maximum to control.

The sensory panellist awarded minimum juiciness scores to T3 and the scores for T1 and T2 were compared to control. This drift might be due to more binding of water by the fiber thus reducing juiciness. Similar findings were reported by Yadav *et al.* (2016) who found that adding dried apple pomace (DAP) and dried tomato pomace (DTP) to chicken sausage reduced its juiciness. According to Yasarlar *et al.* (2007) increasing bran addition masks the meaty flavour and reduces the sensory qualities of meatballs.

The control products scored higher on texture and overall acceptability than the treated products. However, there were minimal variations in these ratings between treatments. Among treatments, sensory panellists had given significantly lower value to T3. This could be owing to the soft texture of apple pulp, which contributes to the treatment product's lower texture score. Thereby sensory panellists may have provided lower ratings because of the treatment's lower flavour and texture scores. Sensory scores of T-1 (3% DAP) and T2 (6% DAP) incorporated sausages were almost similar to control and a significant decline was noticed at T-3 (9% DAP) addition. Overall acceptability scores of pork sausages containing T-2 (6% DAP) were around 7.35. Based on Physico-chemical characteristics, proximate composition, instrumental colour profile, texture analysis and sensory attributes, 6% level of incorporation of DAP were recorded best for the development of high fiber functional pork sausages.

CONCLUSION

Sensory testing revealed that pork sausages with 3 and 6 percent dried apple pulp powder had comparable overall palatability to the control but as the level of incorporation were increased there were a significant decline in the sensory attributes. Therefore the commercial applications of dried apple pulp in the meat industry as functional ingredients is very important and the use of dried apple pulp powder is cost-effective.

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