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Development of Dietary Fibre Enriched Chevon Rolls by Incorporating Corn Bran and Dried Apple Pomace

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ABSTRACT

A study was undertaken to develop dietary fibre enriched chevon rolls using dried apple pomace (DAP) at 2, 4 and 6% levels and corn bran (CB) at 3, 6 and 9% levels. Combinations of DAP and CB were also tried. DAP at 6% level, CB at 3% level and their combination (DAP +CB) at 2% + 3% levels were found to be organoleptically acceptable and selected for further study. Addition of fibre resulted in a significant ($p \leq 0.05$) decrease in moisture and protein content while no significant difference was found in fat and ash content. Crude fibre content increased significantly in treated rolls and highest crude fibre content (1.68%) was noticed in rolls containing DAP. pH decreased significantly in rolls containing DAP and its combination. Water holding capacity and emulsion stability of chevon rolls increased significantly as a result of fibre incorporation which also resulted in a significant increase in cooking yield. Polyphenolic content increased in fibre enriched rolls and highest polyphenolic content of 49.22 mg/100 g was found in DAP added chevon rolls. It is concluded that organoleptically acceptable and health enhancing chevon rolls enriched with dietary fibre and antioxidants like polyphenols can be prepared by using 6% dried apple pomace and 3% corn bran alone or in combination (2% dried apple pomace + 3% corn bran).

Keywords: Chevon rolls, corn bran, dried apple pomace, dietary fibre, polyphenols

A diet high in fibre usually advocates a healthier life-style (Kritchevsky, 2000) and fibre intake can be viewed as a marker of healthy diet. On the other hand, meat as such does not contain any dietary fibre. Moreover meat and its products are considered harmful for health due to their high saturated fatty acid and cholesterol content. Image of meat as a healthy food has diminished in recent years which can be improved by incorporating plant based dietary fibre.

Dietary fibre as a class of compound includes a mixture of plant carbohydrate polymers oligosaccharides and polysaccharides like cellulose, hemicelluloses, pectic substances, gums, resistant starch, inulin that may be associated with lignin and other non carbohydrate components (e.g. phytates, saponins, resistant protein, polyphenols, waxes, cutin). Dietary fibre imparts important functional properties to foods like increased water holding capacity, oil holding capacity, emulsification and gel formation. Dietary fibre incorporated into food products can modify textural properties, avoid synaeresis, stabilise high fat foods and emulsions and improves shelf life (Grigelmo-Miguel and Martina-Belloso, 1999). Fibre has been previously used in cooked meat products to improve cooking yield and texture (Cofrades *et al.,* 2000).

Corn bran which is a byproduct of milling industry, is high (76–90%) in dietary fibre content (Burge and Duensing, 1989) and its total dietary fibre content is higher than wheat bran (44.46%) and rice bran (27.04%) (Prosky *et al.,* 1988). Corn bran provides high water holding capacity and has the ability to absorb faecal mutagens in human digestive track, protecting the body from the ill effects of these mutagens. Corn fibre does not display its own taste and possesses antioxidant activity due to presence of bioactive compounds (Bauer *et al.,* 2013).

Dietary fibres from cereals are used more commonly than those from fruits. However, fruit fibres have better quality due to higher total and soluble fibre content, water and oil holding capacity, colonic fermentability and lesser phytic acid content and caloric value (Larrauri, 1999).

Apple pomace is the main solid waste generated in apple juice factories and contains more than 80% moisture. It has high (78.2–89.8%) dietary fibre content (Figuerola *et al.*, 2005). Soluble dietary fibres present in apple pomace are recognized for blood cholesterol lowering functions (Kaushal and Joshi, 1995).

Apple pomace also has high antioxidant properties due to presence of polyphenols and bioactive compounds (Sudha, 2011) and is recognized better in quality than other dietary fibre sources (Wolfe and Liu, 2003). Due to its functional characteristics (water holding, gelling, thickening and stabilizing abilities), nutrients and phytochemicals, apple pomace has been incorporated by researchers in a range of food products like sausages, jams and baked goods (Henriquez *et al.*, 2010). Drying of apple pomace results in a drastic improvement in its dietary fibre content due to loss of moisture.

Very little work has been done on the development of fibre enriched meat product using corn bran and apple pomace. Hence, keeping above points in view, this study was carried out for development of chevon rolls by incorporating corn bran (CB) and dried apple pomace (DAP) as dietary fibre sources and study the effect of fibre incorporation on organoleptic, nutritional and physicochemical quality of developed products.

MATERIALS AND METHODS

Procurement and processing of dietary fibre sources

Apples were procured from local market. They were washed with clean water and juice was extracted in juicer in the department. Apple pomace obtained after extraction of juice was washed gently with clean water. Water was removed from apple pomace by squeezing in muslin cloth and it was dried at 60ºC in a tray drier. Dried pomace was powdered in a grinder, packed in a polythene bag and stored in deep freezer (-18ºC) for further use. CB was procured from Vitarich Pvt. Ltd., Kolkata.

Processing of goats

The goats were slaughtered and dressed as per the standard procedure in the slaughter house of the department. Carcasses were washed meticulously to remove extraneous material. They were deboned manually after removal of visible fat and connective tissue. Deboned meat was frozen for 24 hours in a deep freezer (-18ºC). Deboned and frozen meat was minced in an electrical mincer (4 mm plate) and used for preparation of chevon rolls.

Preparation of chevon rolls

For preparation of control chevon rolls, minced meat (77.2 g) was added with sodium chloride (1.6 g), sodium tripolyphosphate (STPP) (0.3 g), sodium nitrite (0.015 g), spice mix (1.9 g), condiments paste (3 g), egg albumin (3 g), water (8 g) and ground nut oil (5 g). Treatments consisted of addition of DAP and CB individually at 2%, 4% and 6% levels and 3%, 6% and 9% levels respectively. Combination of DAP + CB was also used at 2% + 3%, 2% + 4%, 2% + 9% levels. Other ingredients were used in similar concentrations as in control. Mixing of additives and dietary fibre sources was carried out in an electrical mixer for 4-5 min to prepare emulsion.

Steam cooking was done for preparation of chevon rolls. Emulsion was stuffed in autoclavable beakers manually and cooked in a closed container for 30 minutes. After cooking, rolls were taken out and cooled to room temperature, packaged in polythene bags and stored at refrigerated temperature for further study.

One treatment each from DAP, CB and their combination was selected on the basis of sensory evaluation. Final treatments were as follows:

1. Control – Chevon rolls without dietary fibre incorporation
2. DAP-3 – Chevon rolls incorporated with 6% DAP.
3. CB-1 – Chevon rolls incorporated with 3% CB.
4. AC-1 – Chevon rolls incorporated with 2% DAP +3% CB.

Analysis

Proximate composition (moisture, protein, fat and ash) and crude fibre content of dietary fibre sources

Table 1: Proximate composition of dried apple pomace and corn bran

Fibre sources	Moisture	Protein	Fat	Ash	Crude Fibre	pH
DAP	4.11±0.48^{b}	2.81±0.40^{b}	4.16±.52^{a}	1.84±0.13^{a}	21.01±1.58^{a}	4.59±0.05^{b}
CB	10.03±0.41^{a}	9.63±0.72^{a}	4.55±1.15^{a}	2.11±0.27^{a}	17.07±0.39^{b}	5.97±0.06^{a}

DAP=Dried apple pomace, CB= Corn bran.
(n=6, Mean ±SD)
Means with different superscripts within a column differ significantly ($p<0.05$).

and chevon rolls was determined as per the standard procedure of AOAC (1995). pH was determined as per procedure of Trout *et al.* (1992). Weight of chevon rolls before and after cooking was recorded and yield was expressed in percentage. Standard methods were used to determine emulsion stability (Baliga and Madaiah, 1970), water holding capacity (WHC) (Wardlaw *et al.*, 1973), polyphenolic content (Swain and Hills, 1959) of control and treated rolls. Force needed to shear one cm^3 piece of roll was recorded using Warner Bratzler Shear probe (Texture analyser, Stable micro systems).

Sensory evaluation was carried by a semi trained panel of four members consisting of scientists and post graduate students of the department. Sensory attributes viz: colour, flavour, texture, tenderness, juiciness and overall acceptability (OAA) of chevon rolls were evaluated using a 9-point Hedonic scale (where 9 indicates like extremely and 1 indicates dislike extremely).

Data obtained from six replicates were subjected to statistical analysis using Duncans Multiple range test by using SPSS software for finding out the significant difference in the mean values. Critical difference was determined at 5% level of significance.

RESULTS AND DISCUSSION

Proximate composition and pH of fibre sources

Moisture and protein content of DAP was significantly lower than CB (Table 1). Difference in the moisture content between two fibre sources was due to difference in processing methods of the two fibre sources. As apple pomace was dried in hot air drier for removal of moisture which resulted in significantly ($p \leq 0.05$) lower moisture content in DAP. Difference in protein content between two fibre sources might be due to difference in their composition. No significant difference was found in fat and ash content between the fibre sources. Crude fibre content of DAP was 21.01% which was significantly higher than that of CB (17.07%). Gazalli *et al.* (2013) had reported crude fibre content of 20.06% in DAP. pH of DAP was significantly lower than that of CB which was due to slightly acidic pH of fruits like apple.

Selection of suitable level of dietary fibre sources

Sensory scores of chevon rolls incorporated with DAP, CB and their combination are presented in Table 2. Addition of DAP resulted in improvement in colour scores and significantly higher scores (8.46) in comparison to control were observed in treatment DAP- 3 having 6% DAP. Higher colour scores in treated chevon rolls might be due to increased content of apple pomace containing peel which provided desirable red colour to chevon rolls. Addition of CB alone or in combination with DAP did not result in any significant effect on colour scores of chevon rolls. Yasarlar *et al.* (2007) had also reported no significant difference in colour scores of Turkish meat balls after addition of CB at 10 and 15% level. Flavour scores declined significantly at 6% level in DAP treated rolls. All rolls containing CB alone or in combination with DAP had significantly lower flavour scores. Decrease in flavour scores of fibre incorporated rolls might be due to increased perception of apple and bran flavour and masking of meaty flavour. Yasarlar *et al.* (2007) have reported that increased bran addition results in masking of meaty flavour. Bloukas and Paneras (1996) have also reported that low fat frankfurters with 3% added rice bran negatively affected the flavour and overall acceptability of frankfurters. Texture and tenderness scores decreased significantly at 6% level in DAP treated rolls.

In CB treated rolls, significant decline in texture was noticed at 6% level, whereas all CB treated rolls had

Table 2: Sensory score of dried apple pomace and corn bran incorporated chevon rolls

Treatments	Colour	Flavour	Texture	Tenderness	Juiciness	OAA
Dried apple pomace incorporated rolls						
Control	7.75±0.62^{b}	7.96±0.45^{a}	7.88±0.53^{a}	8.00±0.43^{a}	7.96±0.58^{a}	7.96±0.62^{a}
DAP-1	7.79±0.58^{b}	7.88±0.68^{ab}	7.83±0.49^{a}	7.92±0.51^{a}	7.79±0.62^{a}	7.83±0.58^{a}
DAP-2	8.17±0.54^{ab}	7.58±0.47^{ab}	7.58±0.47^{ab}	7.58±0.42^{ab}	7.54±0.50^{ab}	7.58±0.36^{ab}
DAP-3	8.46±0.54^{a}	7.46±0.45^{b}	7.25±0.45^{b}	7.33±0.65^{b}	7.21±0.40^{b}	7.25±0.40^{b}
Corn bran incorporated rolls						
Control	7.75±0.62	7.96±0.45	7.88±0.53	8.00±0.43	7.95±0.62	7.95±0.62
CB-1	7.63±0.64^{a}	7.42±0.47^{b}	7.50±0.71^{a}	7.46±0.50^{b}	7.58±0.55^{a}	7.50±0.52^{a}
CB-2	7.58±0.67^{a}	6.92±0.63^{c}	6.63±0.70^{b}	6.54±0.66^{c}	6.45±0.78^{b}	6.54±0.78^{b}
CB-3	7.58±0.79^{a}	6.08±0.47^{d}	6.25±0.66^{b}	6.17±0.44^{c}	6.00±0.60^{b}	6.08±0.73^{b}
Dried apple pomace + Corn bran incorporated rolls						
Control	7.75±0.62	7.96±0.45	7.87±0.52	8.00±0.42	7.95±0.58	7.95±0.62
AC-1	7.75±0.45^{a}	7.33±0.57^{b}	7.33±0.61^{b}	7.25±0.39^{b}	7.29±0.58^{b}	7.29±0.45^{b}
AC-2	7.95±0.58^{a}	6.91±0.90^{c}	7.00±0.73^{b}	6.75±0.62^{c}	6.83±0.57^{bc}	6.75±0.58^{c}
AC-3	8.04±0.58^{a}	6.50±0.52^{d}	6.41±0.66^{c}	6.45±0.49^{c}	6.54±0.54^{c}	6.58±0.41^{c}

DAP-1, DAP-2, DAP-3= Chevon rolls incorporated with 2, 4 and 6% dried apple pomace respectively.

CB-1, CB-2, CB-3= Chevon rolls incorporated with 3, 6 and 9% corn bran respectively.

AC-1, AC-2, AC-3= Chevon rolls incorporated with 2% DAP+3% CB, 4% DAP+3% CB and 6% DAP+3% CB respectively.

(n=12, Mean ±SD)

Means with different superscripts within a column for a particular fibre treatment differ significantly ($p<0.05$).

significantly lower tenderness scores. All the combinations of DAP and CB also had significantly lower texture and tenderness scores. Inclusion of fibres in meat products increases hardness (Fernadez-Gines *et al.*, 2004) resulting in decreased texture and tenderness scores. Juiciness and overall acceptability (OAA) scores decreased in fibre incorporated rolls and significant decrease was noticed at 6% level in DAP and CB treated rolls while all the rolls containing both DAP and CB had significantly lower juiciness and OAA scores. Lower juiciness scores might be due to less perception of meat juices due to fibre incorporation. Decreased flavour, texture, tenderness and juiciness scores of fibre incorporated rolls resulted in a decrease in their OAA scores. Increasing levels of combination of psyllium husk with rice bran (Mehta *et al.*, 2013a) and black gram hull (Mehta *et al.*, 2013b) resulted in a decrease in sensory scores of chicken rolls and patties.

Still the scores of treatments DAP-3, CB-1 and AC-1 containing 6% DAP, 3% CB and 2% DAP + 3% CB respectively were more than 7.0 meaning more than moderate acceptability. So these treatments were selected for further study.

Proximate composition and polyphenolic content of fibre incorporated chevon rolls

Proximate composition of fibre incorporated chevon rolls is presented in Table 3. Moisture content decreased on addition of DAP and CB and significant decrease in comparison to control was noticed in treatments DAP-3 and AC-1. Low moisture content might be due to quantitative replacement of meat with dietary fibre sources containing very low moisture (4.11 to 10.03%) in comparison to meat. Decrease in moisture content after addition of cereal bran has been reported by Yilmaz (2004) and Yasarlar *et al.* (2007). Control treatment had highest protein content and it decreased significantly in fibre enriched rolls. Lower protein content in treated rolls was due to less protein content in fibre sources in comparison to meat. Saricoban *et al.* (2009) reported that addition of wheat bran decreased protein and increased fat content of cooked beef patties. No significant difference was noticed

Table 3: Proximate composition and physico-chemical properties of dried apple pomace and corn bran incorporated chevon rolls

	Control	DAP-3	CB-1	AC-1
Moisture (%)	68.78±0.80^{a}	67.10±0.86^{c}	68.32±0.73^{ab}	67.50±0.66^{bc}
Protein (%)	18.78±0.53^{a}	16.75±0.60^{c}	17.86±0.71^{b}	17.30±0.47^{bc}
Fat (%)	6.30±0.37^{a}	5.95±0.50^{a}	6.16±0.59^{a}	5.90±0.38^{a}
Ash (%)	2.70±0.22^{a}	2.45±0.25^{a}	2.60±0.32^{a}	2.57±0.20^{a}
Crude Fibre (%)	0.28±0.07^{d}	1.68±0.31^{a}	0.83±0.19^{c}	1.32±0.35^{b}
Polyphenolic content (mg/100 g)	ND	49.22±1.68^{a}	3.56±0.60^{c}	19.60 ±1.20^{b}
WHC (%)	30.35±0.60^{c}	37.52±0.98^{a}	33.78±0.71^{b}	34.35±0.71^{b}
pH	6.18±0.04^{a}	5.83±0.03^{c}	6.14±0.05^{a}	6.07±0.05^{b}
ES (%)	85.06±0.70^{d}	89.91±0.71^{a}	86.91±0.68^{c}	88.55±0.96^{b}
CY(%) (n=3)	88.94±0.66^{c}	91.81±0.58^{a}	90.35±0.54^{b}	90.90±0.84^{ab}
Shear press value (Kg/cm^{3})	1.02±0.36	1.45±0.27	1.37±0.56	1.42±0.45

DAP-3= dried apple pomace (6%), CB-1= corn bran (3%), AC-1=dried apple pomace (2%) + corn bran (3%)

(n=6, Mean ±SD)

Means with different superscripts within a row differ significantly ($p<0.05$).

in fat and ash content between control and treated rolls. A crude fibre content of 0.28% was recorded in control rolls. This was due to presence of spices and condiments which contributed to fibre content in control rolls. All the treated rolls had significantly higher crude fibre content than control. This was due to presence of crude fibre in DAP (21.01%) and CB (17.07%). Significantly higher crude fibre content was noticed in treatment DAP-3 in comparison to treatments CB-1 and AC-1. This was due to higher crude fibre content in DAP in comparison to CB. Moreover, higher amount of DAP in the treatment DAP-3 also resulted in significantly higher crude fibre content. Addition of apple pulp at a level of 8 to 10 g/100 g formulation of low salt and low fat chicken nuggets has been reported to increase the dietary fibre content (Verma *et al.,* 2010).

Polyphenols were not detected in control chevon rolls (Table 3). Presence of polyphenols in DAP and CB resulted in polyphenolic content in treated rolls. Polyphenol content of treatment DAP-3 was 49.22 mg/100g which was significantly highest. A number of phenolic compounds like phenolic acids, flavonoids, chlorogenic acid, phloridzin and quercetin glycosides are found in apple pomace (Garcia *et al.,* 2009). Addition of apple skin powder to muffins increased their phenolic content (Rupasinghe *et al.,* 2008). CB-1 treatment had polyphenol content of 3.56 mg/100 g which was much lower than DAP-3 treatment. This might be due to less amount of polyphenols in CB as compared to DAP. Few of the phenolic antioxidants like ferulic acid are present in corn bran (Graf, 1992).

Physico-chemical properties of fibre enriched rolls

WHC of control rolls was 30.35% (Table 3). Treated rolls had significantly higher WHC than control. WHC of DAP-3 treatment was significantly higher than CB-1 and AC-1 treatments. Grigelmo-Miguel and Martin-Belloso (1999) also reported that peach dietary fibre was effective in retaining added water in low fat high dietary fibre frankfurters.

pH of control rolls was 6.18 and no significant difference was noticed in pH of control and CB-1 rolls. Significant decline in pH in comparison to control was noticed in DAP added treatments i.e. DAP-3 and AC-1 rolls. This was due to acidic pH (4.59) of DAP. Inclusion of apple pulp in low fat and low salt chicken nuggets resulted in a significant decrease in pH (Verma *et al.,* 2010).

Emulsion stability and cooking yield of treated rolls was significantly higher than control. Treatment DAP-3 had highest emulsion stability (89.91%) and cooking yield (91.81%). Results are in agreement with Cofrades *et al.* (2000) who stated that dietary fibres increase cooking yield due to their water and fat binding properties. Emulsion stability and cooking yield increased on incorporation of rice bran at different levels in meat batters (Choi *et al.*, 2007).

Shear press values of control and treated rolls were in the range of 1.02 - 1.42 kg/cm^3. No significant difference was noticed in shear press values of control and treated chevon rolls.

CONCLUSION

Chevon rolls with higher cooking yield and enriched with dietary fibre and antioxidants like polyphenols can be prepared by using 6% dried apple pomace and 3% corn bran alone or in combination (2% dried apple pomace + 3% corn bran).

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