

QUALITY EVALUATION OF BUFFALO MEAT PATTIES INCORPORATED WITH
APPLE POMACE POWDERKaiser Younis^{1,*} and Saghir Ahmad²

ABSTRACT

Meat patties have gained immense popularity due to its delicious and higher nutritional values. In this study, buffalo meat patties were incorporated with apple pomace powder to investigate its effect on quality and sensory parameters of the patty. For this, apple pomace powder was added to patties in different proportions 2, 4, 6 and 8 weight percent (w/w). With an increase in apple pomace powder incorporation the water holding capacity, cooking yield, emulsion stability of meat emulsion increased. After cooking the moisture content, water activity, fat and crude fibre of patties increased while as the pH decreased. The effect on textural properties like firmness, toughness and hardness of patty increased which was well supported with the images of scan electron microscope which showed the compact structure of treated patties. The instrumental colour evaluation indicated that patties turned more red and darker than the control patty. From the sensory analysis of patties only up to 6% incorporation of apple pomace powder were acceptable.

Keywords: *Bubalus bubalis*, buffaloes, apple pomace, patties, buffalo meat, texture, sensory

INTRODUCTION

Consumption of red meat and its concern about the human health is nowadays headline. Red meat is considered highly nutritious with respect to protein quality, vitamins and minerals. However, it is deficient in dietary fibre and due to the processing and preservation, its excess consumption has negative effects on health (WHO, 2015a). Red meat consumption is high all over the world (WHO, 2015b) and is consumed in different forms like patties, sausages, burgers, salami and many cooked dishes. Indeed red meat and its products are preferred foods, because of high-quality proteins, minerals, vitamins, high satiety and tastefulness (McAfee *et al.*, 2010). In addition to this, it has a major share of the agricultural economy but recently International Agency for Research on Cancer has evaluated the carcinogenicity of red meat and processed meat and they concluded that each 50-gram consumption of processed meat on daily basis increases the risk of colorectal cancer by 18% (WHO, 2015a). In order to remove the hazardous taboos of meat, the preservatives like nitrate or smoking need to be replaced with naturally occurring compounds present in plants as a whole (for example apple pomace) or their extract, which is rich in bioactive compounds.

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There a growing demand and appreciation for the enrichment of fruit and vegetables in the diet and improved health (WHO, 2015).

Apple is rich in fibres and bioactive compounds like polyphenols, vitamins, and minerals (Gorinstein *et al.*, 2001; Wijngaard *et al.*, 2009). The apple polyphenols have been proven to have antioxidant and anti-inflammatory activity, inhibit cancer cell proliferation and decrease lipid oxidation which lowers the cholesterol levels (Chai *et al.*, 2012). Apple juices are preferred throughout the world due to which a huge amount of apple pomace is generated. Kennedy *et al.* (1999) have reviewed the numerous ways of utilising apple pomace. Apple pomace is a rich source of dietary fibre which has many physiological benefits due to high soluble fibre and presence of bioactive compounds like antioxidants (Kołodziejczyk *et al.*, 2007; Lu and Yeap Foo, 2000). Previous researchers have shown the versatility of apple pomace as a functional ingredient in different food systems and have been used for the water and oil-holding capacity, fat replacers and bulking agents etc. (O'Shea *et al.*, 2012; Rosell *et al.*, 2009). Keeping in view the functional properties of apple pomace, it has been tried in various meat products like chicken nuggets (Verma *et al.*, 2010), Chicken sausages (Yadav *et al.*, 2016) pork meat (Lantto *et al.*, 2006) and mutton nugget (Huda *et al.*, 2014).

The present work aims at studying the effect on different quality parameters of buffalo meat patties by incorporation of apple pomace powder.

MATERIALS AND METHODS

Halal buffalo meat and fat was purchased from the local meat shops of Aligarh city. It was

stored in a freezer at -18°C for 24 h for further use. Spices and condiments were also purchased from the local market of Aligarh. Apple pomace was collected from the local juice vendors of Aligarh and was dried in a tray dryer to a moisture content of 10%.

Preparation of spices and condiments and apple pomace powder

All spices were grounded in a laboratory grinder and were mixed in a required proportion. The mixed spices were packed in air tight packets and were stored in the refrigerator for further use. Onion and garlic were peeled and the paste was prepared in a grinder in the required ratio. The paste was packed in air tight packs and stored in refrigerated temperature for further use. Apple pomace was also grounded to a particle size of 1.68 mm.

Preparation of patties

Frozen meat and fat was grounded separately in a meat grinder by passing meat through a plate having 6 mm holes. The ingredients of patties were meat (75.49 g), sodium chloride (1.6 g), spice mix (1.9 g), condiments (3 g), ice (8 g) and fat (10 g). For the apple pomace powder incorporation, all the ingredients were kept constant except that of meat which was replaced by apple pomace powder as 0, 2, 4, 6 and 8%. The whole mixtures were mixed in a bowl chopper and the temperature was maintained with the help of ice. Patties were moulded in a patty moulding machine and were cooked in an oven at 175°C until the internal temperature reached 75°C.

Physicochemical properties of patties

Moisture and fat content of patties were carried out as per the standard methods (AACC,

2000). Crude fibre content of apple pomace powder and patties was determined as per (AOAC, 1995). pH meter (EUTECH Instruments CyberScan pH 1500) was used to determine the pH of patties as per a method described by Troutt *et al.* (1992). The water activity of patties were done by cutting small cubes of patties and the cubes were kept in the instrument (AQUA LAB, Dew Point Water Activity Meter 4TE, USA) chamber until the instrument makes an automatic beep sound which gives the final water activity of patties. The cooking yield of patties was determined by taking the weights of patties before and after cooking and is expressed in percentage retained weight (Gadekar *et al.*, 2014). Emulsion stability of patties was done according to the method Baliga and Madaiah (1970). Water holding capacity of patties was done following the method of Bernal *et al.* (1987). 10 grams of the sample was taken in a tube and mixed with 40 ml of distilled water and were kept in water bath at 30°C for 30 minutes followed by centrifugation at 3000 rpm for 30 minutes. Results were calculated in percentage by the below equation:

Water holding capacity % =

$$\frac{\text{Weight of sample after removing supernatant} \times 100}{\text{Weight of sample mixed with distilled water}}$$

The thickness and diameter of patties were determined by using Vernier calliper and were calculated by following the method of Serdaroğlu and Değirmencioğlu, (2004).

Increase in thickness % =

$$\frac{(\text{Cooked patty thickness} - \text{Uncooked patty thickness})}{\text{Uncooked patty thickness} \times 100}$$

Reduction in diameter % =

$$\frac{(\text{Uncooked patty diameter} - \text{Cooked patty diameter})}{\text{Uncooked patty diameter} \times 100}$$

Detail textural analysis

Texture profile analysis was done as per the method is given by Bourne, (1978) TAHD Plus Texture Analyser (Stable Micro Systems, England) was used for this analysis.

Color analysis

Instrumental colour was measured by using a MiniScan XE Plus. Total change in colour (ΔE) was calculated by given below formula to determine the total colour difference between all three coordinates L^* , a^* and b^* a value.

$$\Delta E^* = [\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}]^{1/2}$$

Sensory analysis

Sensory analysis was carried out by five trained panellists. The whole patties were served in white dishes with drinking water. The test was carried out between breakfast and lunch. All the quality attributes like colour, flavour, texture, taste, sweetness, juiciness, mouth coating and overall acceptability were analysed by using nine point hedonic scale. In this scale, nine was considered extremely desirable and one was considered as extremely undesirable.

Scan electron microscope

Meat patties were analysed under scan electron microscope for studying the surface morphology of patties. The patties were cut in small and thin rectangular cubes and were dried in Critical Point Drying at 35°C for 10 cycles. After drying the patty meat cubes were coated with gold and were analysed under scan electron microscope

with 200x.

Statistical analysis

SPSS 16 software was used to find the significant difference between control and treatment by using one way ANOVA. Homogeneous subsets were determined by using Duncan method. The mean difference was significant at the 0.05 level.

RESULTS AND DISCUSSION

Fat content of cooked patties

The fat content of apple pomace incorporated patties is shown in Table 1. It was seen that the fat content of patties incorporated with apple pomace powder was significantly ($P \leq 0.05$) higher than that of control. As the apple pomace powder level was increased the fat content also increased significantly ($P \leq 0.05$) for each level. During cooking the fat melts and exudes from the patties, however, in apple pomace incorporated patties the melted fat gets absorbed by apple pomace powder because of its good oil holding capacity. Furthermore, it has been reported that the apple pomace has some emulsifying activity; which may also be a reason for the prevention of fat loss.

pH of cooked patties

The pH of buffalo meat patties had a decreasing trend with increasing level of apple pomace powder incorporation, which may be due to rather acidic nature of apple pomace powder. The pH of control patties is shown in Table 1 was significantly ($P \leq 0.05$) different from the apple pomace incorporated patties. However, at all levels of apple pomace powder incorporated patties, there was no significant ($P \leq 0.05$) difference in pH from

each level. The same trend has been shown by Rather *et al.* (2015) in a Kashmiri traditional meat product (Goshtaba) where pH has decreased with the addition of apple pomace powder.

Moisture content of cooked patties

Moisture content is an essential quality parameter with respect to juiciness, texture and shelf life of a food product. The desirability of moisture content varies with food and is specific for a particular food. From the Table 1, it has been shown that due to the incorporation of apple pomace powder in patties moisture content increased significantly ($P \leq 0.05$) at all levels of incorporation. Although the same amount of water/ice was added during the patties processing due to the water holding capacity of apple pomace powder, the treated samples has retained water during cooking. Similarly, an increase in moisture content of cooked patties was observed by Kumar *et al.* (2015) with the addition of dietary fibre in mutton patties.

Crude fiber

Crude fibre is the portion of the total carbohydrate of a food that is resistant to the acid and alkali treatment. It comprises of a large fraction of cellulose, some hemicelluloses and portion of lignin. From the Table 1, it has been shown that as the apple pomace concentration was increased in buffalo meat patties the crude fibre percentage increased significantly ($P \leq 0.05$). Since meat is deficient in crude fibre but the presence of 0.6% crude fibre content of control patties was due to spices and condiments. The increasing percentage of crude fibre in treated patties was due to apple pomace which is rich in crude fibre.

Water activity of cooked patties

Water activity is the actual water content present in a food material available to the microorganisms. It provides information about the type of microorganism that can grow in a particular type of food. From the Table 1, it has been observed that water activity of cooked patties got increased with the incorporation of apple pomace powder. The incorporation of apple pomace powder has significantly ($P \leq 0.05$) increased the water activity up to 6% level. However, no significant ($P \leq 0.05$) difference was found between 6% and 8% levels of apple pomace powder incorporation. Kumar *et al.* (2015); Verma *et al.* (2015) have also observed the same trend of increasing water activity of patties with the incorporation of dietary fibre and sweet potato powder respectively.

Water holding capacity of patties

Table 2 shows the water holding capacity of buffalo meat patties. Incorporation of apple pomace powder had a significant ($P \leq 0.05$) effect on the water holding capacity of patties. With an increase in apple pomace powder incorporation, water holding capacity of patties increased from 6.69% to 20.03%. This is because of the water retention capacity of apple pomace powder. Likely, Bernal *et al.* (1987); DeFreitas *et al.* (1997) showed that water holding capacity of meat protein network was increased with the addition of carrageenans due to physical entrapment of water and not due to molecular interaction with meat proteins. Similarly, Morin *et al.* (2004) found increased water-holding ability of reduced-fat sausage system with the addition of barley β -glucan.

Cooking yield and emulsion stability of patties

The emulsion stability, as well as cooking yield, showed an increasing trend with the

incorporation of apple pomace powder in buffalo meat patties. The treated patties were seen with significantly ($P \leq 0.05$) higher values of emulsion stability and cooking yield as compared to control patties. Cooking yield in meat products is usually due to the ability of the protein matrix to retain water and bind fat (Sheridan and Shilton, 2002; Aleson-Carbonell, 2005). However, the results of the present study as shown in the Table 2 suggest that the increase in cooking yield and emulsion stability is due to apple pomace powder incorporation in buffalo meat patties which is having a good water and oil holding capacity. High cooking yield and emulsion stability are considered as a desirable characteristic for patties manufacturing from the quality point of view.

Diameter and thickness of patties

Dimensional characteristics are an important quality parameter for patties preparation. Therefore, change in dimensions due to apple pomace powder incorporation have been considered. Usually, meat products having less shrinkage during cooking are considered to be desirable. From the Table 2 it has been seen that the decrease in diameter and increase in thickness has improved significantly ($P < 0.05$) in apple pomace powder incorporated patties. As the level of apple pomace powder has been increased in patties the shrinkage in diameter was seen less than that of control patties while as the height got increased. This might be due to the higher water holding and swelling capacity of apple pomace powder. This occurrence has also been observed previously by Malav *et al.* (2015) in mutton patties incorporated with cabbage powder.

Texture analysis

The textural properties of control and apple

Table 1. Effect of apple pomace on fat, pH, moisture content and water activity of patties.

Sample	Fat %	pH	Moisture	Crude fiber	Water activity (a_w)
A	3.06±0.41 ^c	6.17±0.12 ^b	62.77±0.25 ^c	0.63±0.15 ^c	0.81±0.01 ^d
B	4.19±0.27 ^d	6.07±0.03 ^a	63.27±0.25 ^d	2.03±0.25 ^d	0.84±0.02 ^c
C	6.42±0.38 ^c	6.03±0.04 ^a	64.33±0.35 ^c	3.27±0.25 ^c	0.89±0.01 ^b
D	10.11±0.67 ^b	6.00±0.00 ^a	65.20±0.26 ^b	4.15±0.11 ^b	0.93±0.02 ^a
E	11.13±0.14 ^a	5.75±0.18 ^a	66.17±0.21 ^a	5.11±0.10 ^a	0.95±0.01 ^a

A, B, C, D and E are the samples incorporated with apple pomace powder as 0, 2, 4, 6 and 8% respectively. Means bearing different superscripts in a column differ significantly ($P<0.05$).

Table 2. Effect of apple pomace on water holding capacity, cooking yield, emulsion stability, diameter and thickness of patties.

Sample	WHC	Cooking yield	Emulsion stability	Percent decrease in diameter	Percent increase in thickness
A	6.69±0.20 ^d	70.61±0.97 ^d	62.49±0.49 ^c	30.54±0.26 ^a	38.83±3.44 ^b
B	12.48±0.74 ^c	72.56±0.73 ^c	66.40±0.46 ^d	30.27±0.55 ^a	39.53±2.87 ^b
C	13.28±0.25 ^b	73.63±0.55 ^c	72.10±0.97 ^c	28.54±0.35 ^b	50.12±2.34 ^a
D	19.80±0.26 ^a	78.12±0.33 ^b	74.63±0.55 ^b	25.82±0.23 ^c	53.72±3.79 ^a
E	20.03±0.15 ^a	98.17±0.37 ^a	80.67±0.76 ^a	23.06±20.45 ^d	55.28±4.74 ^a

A, B, C, D and E are the samples incorporated with apple pomace powder as 0, 2, 4, 6 and 8% respectively. Means bearing different superscripts in a column differ significantly ($P<0.05$).

Table 3. Effect of apple pomace powder on textural properties of buffalo meat patties.

Sample	Firmness	Toughness	Hardness (Ncm ⁻²)	Cohesiveness	Gumminess	Chewiness	Springiness
A	13.01±0.37 ^c	142.60±0.79 ^d	47.85±1.71 ^c	0.60±0.02 ^a	28.66±1.62 ^d	17.19±1.57 ^c	0.81±0.03 ^a
B	16.36±0.57 ^b	175.48±0.78 ^c	61.83±0.49 ^d	0.58±0.06 ^{ab}	35.71±3.54 ^c	20.78±4.12 ^{bc}	0.82±0.06 ^a
C	17.47±0.47 ^b	176.80±1.65 ^c	65.40±1.08 ^c	0.57±0.05 ^{ab}	36.91±3.36 ^c	20.94±3.77 ^{bc}	0.81±0.03 ^a
D	19.45±2.43 ^b	209.81±0.99 ^b	85.45±1.24 ^b	0.55±0.04 ^{ab}	47.01±3.28 ^b	25.93±3.45 ^{ab}	0.79±0.01 ^{ab}
E	24.28±2.74 ^a	256.83±1.74 ^a	109.54±1.25 ^a	0.52±0.01 ^b	56.93±0.57 ^a	29.60±0.60 ^a	0.74±0.03 ^b

A, B, C, D and E are the samples incorporated with apple pomace powder as 0, 2, 4, 6 and 8% respectively.

Means bearing different superscripts in a column differ significantly (P<0.05).

apple pomace powder incorporated patties are presented in Table 3. Firmness, toughness, hardness, gumminess and chewiness of patties has increased significantly ($P \leq 0.05$) with the incorporation of apple pomace powder. However, the effect of apple pomace powder on cohesiveness and springiness was not prominent up to 6% level but a significant ($P \leq 0.05$) difference was found above that. This may be due to higher water and oil holding capacity of apple pomace due to which firm and turgid patties were formed as compared to the control patties. Also from the scan electron, microscopic results the matrix of treated patties was found continuous and firm as compared to the control which was having voids. A similar trend was observed by Yadav *et al.* (2015) in chicken sausages with the incorporation of apple pomace.

Colour analysis

Colour is measured as one of the important and significant quality attributes associated with meat and meat products. These attributes are

generally measured as L^* (lightness-darkness), a^* (green-red) and b^* (yellow-blue). The L^* , a^* and b^* values of buffalo meat patties are presented in Table 4. It was found that the L^* and b^* values of buffalo meat patties were significantly ($P \leq 0.05$) decreased with the incorporation of apple pomace powder. However, the red colour (a^* value) of patties had significantly ($P \leq 0.05$) increased. This may be due to the red colour of apple skin already present in pomace. Total colour change (ΔE) is another representation of L^* , a^* and b^* values for determining the effect of different treatments on the colour of buffalo meat patties. The total colour change was obtained by comparing the control patties with all the levels of treatments as shown in Table 4. From the data, the total colour change of control patties increased from 5.24 to 7.30 with the incorporation of apple pomace powder showing its positive effect on the colour of patties.

Scan electron microscope

Figure 1 shows the scan electron

Table 4. Effect of apple pomace powder incorporation on colour of patties.

Treatments	L^*	a^*	b^*
A	33.64±0.94 ^a	13.62±0.08 ^d	14.24±0.25 ^a
B	28.56±0.59 ^b	14.62±0.72 ^{bc}	13.70±0.20 ^b
C	28.45±0.90 ^b	15.42±0.27 ^{ab}	13.24±0.10 ^c
D	28.16±0.94 ^b	16.22±0.25 ^a	13.11±0.17 ^c
E	27.19±0.78 ^b	16.30±1.08 ^a	12.53±0.25 ^d
ΔE			
A and B		5.24±1.51	
A and C		5.62±1.65	
A and D		6.22±1.70	
A and E		7.30±1.05	

A, B, C, D and E are the samples incorporated with apple pomace powder as 0, 2, 4, 6 and 8% respectively. Means bearing different superscripts in a column differ significantly ($P < 0.05$).

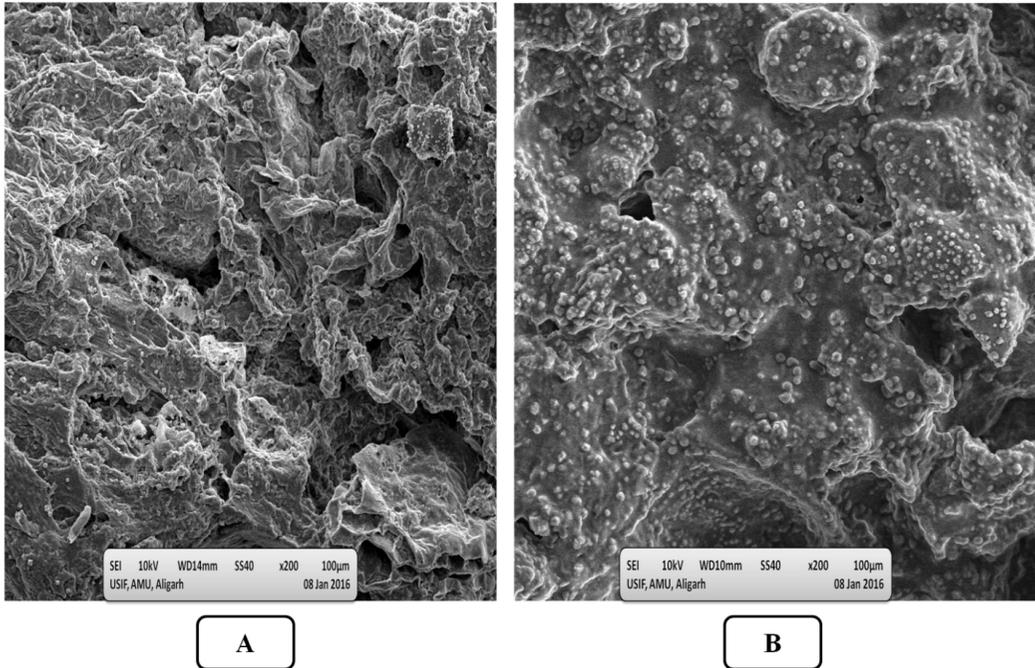


Figure 1. Scan electron microscope images of buffalo meat patties.

A is control buffalo meat patties and B is buffalo meat patties incorporated with 6% apple pomace powder.

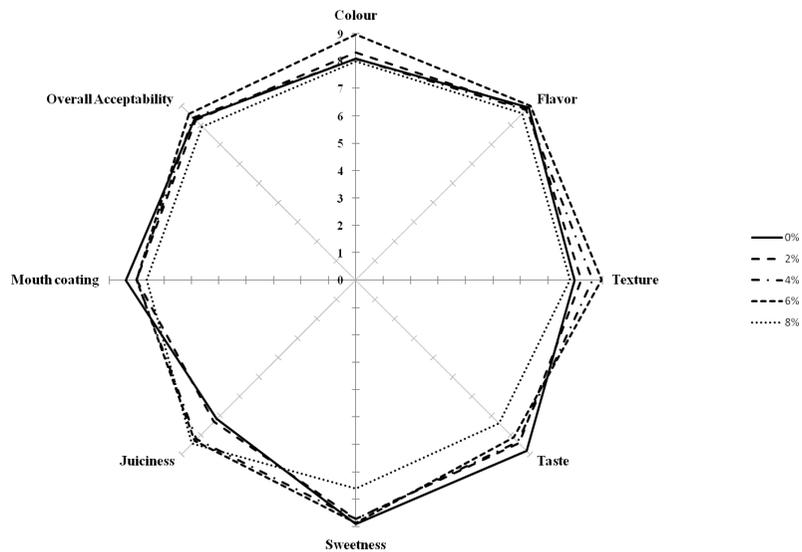


Figure 2. Sensory analysis of buffalo meat patties incorporated with apple pomace powder.

0, 2, 4, 6 and 8% are control and increasing levels of apple pomace powder incorporation in buffalo meat patties.

microscopic images for control (A) and 6% (B) apple pomace powder incorporated buffalo meat patties. From the Figure (A) a non-homogeneous or noncompact material, full of large cavities was seen where as the Figure (B) shows a homogeneous and compact structure. In later the apple pomace powder particles have helped the meat particle in adhesion and are well entrapped in the meat matrix provided the patties compact structure which was well supported by the higher values of textural properties like firmness, toughness and hardness. Further, the compactness may be due to the functional properties of apple pomace powder like water and oil holding capacity due to which the emulsion stability of meat products is stabilised. The cavities present in the control patties are the signs of cooking losses during the processing leaving behind a less compact matrix.

Sensory analysis of patties

The sensory results of treated buffalo meat patties and control are presented in Figure 2. Different quality parameters were analysed by sensory panellists like colour, flavour, texture, taste, sweetness, juiciness, mouth coating and overall acceptance. Colour of patties was found acceptable up to 6% apple pomace powder incorporation but due to the colour of apple pomace powder the sensory scores at 8% level was decreased. The effect of apple pomace powder on the flavour was insignificant ($P \leq 0.05$) up to 4% level but showed significant ($P \leq 0.05$) difference at 6 and 8% levels. A significant ($P \leq 0.05$) effect of apple pomace powder on the texture of patties was observed and it was found that 6% level has achieved the highest score. The taste of patties decreased with the increase of apple pomace powder incorporation which might be due to the additional taste produced by the apple pomace powder. It was further supported by the

scores obtained for sweetness which has decreased with the increasing levels of apple pomace powder. As usually, patties are salty and spicy so the sweet sensation due to apple pomace was not encouraged by the panellists. The juiciness of patties had a significant ($P \leq 0.05$) increase with the incorporation of apple pomace powder because of the good water holding capacity of apple pomace powder. Mouth coating is a negative quality parameter of animal fats. It was found that the mouth coating has significantly ($P \leq 0.05$) increased in the apple pomace powder incorporated patties and was prominently visible at 8% level. The reason for this was the presence of more fat in treated patties due to good oil holding capacity of apple pomace powder. Finally, from the overall acceptance, the best sample obtained from the results of sensory panellists was (8.61) for 6% apple pomace powder incorporated patties. How over further increasing of apple pomace powder incorporation has decreased the acceptability of the product.

CONCLUSION

Apple pomace powder was used as a functional ingredient in Buffalo meat patties and its effects on different quality parameters were evaluated. Incorporation of apple pomace powder in patties has increased the cooking yield, emulsion stability, water holding capacity, diameter and thickness of buffalo meat patties. The texture of patties like firmness, toughness, hardness and cohesiveness has increased as compared to control patties which were better supported with homogeneous and firm structure revealed by the scan electron microscope. Sensory evaluation indicated that the incorporation of apple pomace powder in buffalo meat patties was acceptable up

to 6% level of incorporation. The above results have shown the potential of apple pomace powder in the meat industry.

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