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Sensory Acceptability of Low Salt Buffalo Calf Meat Rolls Enriched with Dried Plum Powder (DPP) and Dried Apple Pomace Powder (DAPP) during Refrigerated Storage

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ABSTRACT

The study was planned with an objective to evaluate the sensory features during refrigerated storage of a functional product *i.e,* low salt buffalo calf meat rolls enriched with dietary fiber by incorporating dried plum powder (DPP) and dried apple pomace powder (DAPP). The scores for colour and appearance declined with advancement in storage period irrespective of the treatments and on 15th day of storage, the colour and appearance scores for all the treatments were between 6.0 to 7.0 indicating moderate to very good acceptability. Similarly flavour scores decreased significantly($P \leq 0.05$) in all the treatments with the advancement of storage days however flavour scores of all the treatments were comparable with control at the end of 15 days and except the treatment T3, the scores for all other treatments were above 6.0. There was significant decline noticed in texture, juiciness and tenderness scores in all treatments with increase in storage days and at the end of storage of 15 days, all treatments except T3 had comparable tenderness scores. Over all acceptability(OAA) scores decreased significantly ($P \leq 0.05$) in all the treatments with advancement in storage period and except T3, no significant difference in OAA was noticed among different treatments and scores were well above 6.0.
Keywords: *Buffalo calf, meat rolls, low salt, fiber enriched*

INTRODUCTION

The total livestock population in India according to the 20th livestock census is 535.78 million heads including 109.85 million buffaloes (20.45 %) with first rank in world buffalo population (BAHFS, 2019). India exported 1.26 million tonnes of buffalo meat, in financial year 2024-25 (APEDA, 2026). Despite huge population and remarkable contribution of buffaloes to the total meat production in the country, their potential has not been fully exploited in the processed meat industry. Unlike cow, buffalo meat does not have any religious connotations and its slaughter and export is permitted under the Indian laws. It has roughly 2-3 folds cost advantage over mutton and chevon. However the farmers do not consider raising male buffalo calf to be financially rewarding, eventually the country experiences immense loss in respect of elevated mortality rate of male buffalo calves (80 % to 84.69 %) on account of poor care and managemental practices (Tiwari *et al.*, 2007). It is estimated that about 10 million male buffalo calves are born annually in India but owing to low utility; their feeding is ignored leading to high mortality and poor growth in surviving calves (FAO, 2014). The male buffalo calves are not basically grown for meat production by the Indian farmers and even allowed to die intentionally to save the milk from the dam to earn more revenue in the market (Ranjhan, 2008).

The meat of buffalo especially the calf needs to be popularized and explored for the trending products like functional

food to explore the real potential of this type of meat for the target population. There are several approaches for the functional food development; out of which the low salt meat products enriched with fiber is most demanding now a days. The apprehensions regarding high sodium intake from the diet has necessitated to evolve strategies to minimize the salt added to products and also reconsideration of product recipes employing salt substitutes to minimize the proportion of salt in different food products formulations (Pietrasik and Gaudette, 2015). Various researchers have recommended that the partial substitution of sodium chloride with potassium chloride (KCl) is one of the finest alternatives to alleviate the sodium level in meat products (Lorenzo *et al.,* 2015). The next important issue in meat products is the lack of fiber content as inherently meat itself is not a good source of fiber; necessitating the need to enrich the developed products having important source of fiber in their formulations. Dietary fibre has the ability to bind with bile acids and metabolites of cholesterol which exhibit a significant role in digestion and absorption of lipids in small intestine (Mehta *et al.*, 2015). The fibre rich diets results in slowing down of gastric emptying resulting in efficient nutrient absorption (Brennan, 2005). Dietary fibre slows the absorption of glucose in the intestines, lowers cholesterol and low density lipid levels and enhances the intestinal health (Kosmala *et al.*, 2011). In addition, dietary fibre renders technological functions like water binding and water retention, thereby decreasing shrinkage, cooking loss and drip loss during storage and neutralizing the undesired textural variations without altering sensory characteristics of the final product (Henning *et al.,* 2016). Thus, inclusion of dietary fibre in meat products may upgrade their nutritional composition and acceptability in addition to providing health benefits. Hence the present study is planned to explore the keeping quality of developed product with respect to sensory acceptability during common refrigerated storage condition of 4±2°C.

MATERIALS AND METHODS

Raw materials: Healthy male buffalo calves of 10 months of age were slaughtered and dressed as per the standard procedure in the experimental slaughter house and dressed carcasses were washed thoroughly and deboned manually after trimming of visible fat and connective tissue. Deboned meat was packed in LDPE (low density poly ethylene) bags and stored at -18±2°C. The frozen chunks were drawn as per requirement and thawed overnight in a refrigerator (4±2°C) and were used for development of meat rolls. Plum pulp and peel were obtained from fresh plum fruits. These were washed gently with clean water, squeezed in a muslin cloth and dried in a tray drier at 60°C. Dried plum pulp and peel were powdered in a domestic grinder, packed in air tight polyethene bags and stored in deep freezer (-18 ±2°C) for further use. Similarly apples 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 a muslin cloth. It was dried at 60°C in a tray drier. Dried pomace was powdered in a domestic grinder and packed in air tight polythene bags and stored in deep freezer (-18 ±2°C) for further use. All the chemicals, ready made culture media, standards were procured from reputed firms like Qualigens, CDH, Hi-Media, Sigma-Aldrich. Similarly the food grade ingredients were procured from local market for the product preparation.

Preparation of calf meat rolls : For preparation of control meat rolls, sodium chloride (2 %), sodium tripolyphosphate (0.5 %), sodium nitrite (150 ppm), spice mix (2 %), condiments (3 %), chilled water (10 %), groundnut oil (7 %), bread crumbs powder (4 %), whole egg liquid (8 %), sugar (1 %) and citric acid (0.05 %) were mixed with double minced meat. Stable emulsion was prepared in a meat mixer/ bowl chopper. The prepared emulsion was stuffed manually in autoclavable beakers and distributed uniformly with the help of glass rod. The beakers were covered with aluminium foil and steam cooked in a closed container for 35 minutes. After cooking, rolls were taken out and cooled to room temperature, packaged in polythene bags and stored at refrigerated temperature (4 ±2°C) for further study.

For preparation of low salt meat rolls, sodium chloride was substituted partially with potassium chloride, potassium lactate by maintaining equivalent Ionic Strength (IS) to that of 2 % NaCl (0.342). Low salt fibre treated meat rolls developed by substituting 30 % NaCl with combination of potassium chloride (10 %) + potassium lactate (20 %) where the level was decided on the basis of sensory observations. Selected level of low salt meat roll was incorporated with dried plum powder (DPP) and dried apple pomace powder (DAPP) at 2 %, 4 % and 6 % levels individually to develop low salt fibre enriched buffalo calf meat rolls (Table 1).

Table 1. Composition of meat emulsion for low salt fibre enriched buffalo calf meat rolls

Ingredients (g)	C ontrol	Control LS	T1	T2	T3	T4	T5	T6
Meat	100	100	100	100	100	100	100	100
NaCl	2 (IS-0.342)	1.4 (IS-0.2394)	1.4 (IS-0.2394)	1.4 (IS-0.2394)	1.4 (IS-0.2394)	1.4 (IS-0.2394)	1.4 (IS-0.2394)	1.4 (IS-0.2394)
KCl (IS-0.0342)	-	0.253	0.253	0.253	0.253	0.253	0.253	0.253)

K-lactate (IS-0.0684)	-	0.872	0.872	0.872	0.872	0.872	0.872	0.872
STPP	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sodium nitrite	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Spice mix	2	2	2	2	2	2	2	2
Bread crumbs powder	4	4	4	4	4	4	4	4
Condiments	3	3	3	3	3	3	3	3
Chilled water	10	10	10	10	10	10	10	10
Ground nut oil	7	7	7	7	7	7	7	7
Whole egg liquid	8	8	8	8	8	8	8	8
Sugar	1	1	1	1	1	1	1	1
Citric acid	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Dried plum powder (DPP)	-	-	2	4	6	-	-	-
Dried apple pomace powder (DAPP)	-	-	-	-	-	2	4	6

Sensory evaluation: A four member experienced panel of judges consisting of faculty members and students of the Department evaluated the samples for the sensory attributes of colour and appearance, flavour, texture, tenderness, juiciness and overall acceptability using 8-point descriptive scale (Keeton, 1983), where 8=excellent and 1=extremely poor. The test samples were presented to the panelists after assigning the suitable codes. The samples were warmed in a microwave oven for 20 seconds before serving to the sensory panelists. Water was served for rinsing the mouth between the samples.

Statistical Analysis: Data obtained was subjected to statistical analysis using Tukey's test by using 'SPSS-16.0' (SPSS Inc., Chicago, II USA) software to find out the significant difference at 5 % significance level in the mean values.

RESULTS AND DISCUSSION

Colour and Appearance: There was no significant difference observed in colour and appearance scores of control, control LS (control low salt) and dried plum powder (DPP) treated meat rolls on 0 day of storage. Salt substituted rolls treated with DPP up to 4 % level were also comparable with both types of controls. But further addition of DPP at 6 % level resulted in significant decline in colour and appearance scores of treated rolls in comparison to both the controls. The scores for colour and appearance declined with advancement in storage period irrespective of the treatments. The decrease in colour and appearance scores of buffalo calf meat rolls might be owing to surface dehydration in aerobic packaging (Kumar and Sharma, 2003) and pigment and lipid oxidation (Bhat *et al*., 2011) during refrigerated storage.

On 15th day of storage, the colour and appearance scores for all the treatments were comparable and the scores were between 6.0 and 7.0 indicating moderate to very good acceptability(Table 2). Nunez De Gonzalez *et al*. (2008) noticed that injection of plum ingredients up to 5 % into precooked roasted beef had negligible impact on colour and appearance in comparison to control. Yildiz-Turp and Serdaroglu (2010) reported no significant difference in colour and appearance of control and low fat beef patties containing 5 % plum puree.

Flavour: The flavour scores of fresh meat rolls ranged from 6.79 to 7.83. No significant difference in flavour scores was noticed between full salt and salt substituted control throughout the storage period (Table 3). Gelabert *et al*. (2003) did not notice any significant flavour defect when NaCl was partially replaced (up to 40 %) with mixtures of KCl and glycine or potassium lactate and glycine. Incorporation of DPP up to 4 % to low salt rolls did not cause any significant decrease in flavour scores with respect to both the controls. But further increase in DPP at 6 % (T3) resulted in significant decline in flavour scores. Leheska *et al*. (2006) reported that increasing level of dried plum puree in breakfast pork sausage significantly enhanced sweet flavour causing decline in flavour score. The flavours scores for low salt DAPP added rolls were comparable with full salt and low salt control up to 4 % DAPP addition and further increase in DAPP level to 6 % resulted in significant decline in flavour scores. However, all DAPP treated rolls had flavour scores more than 7.0 on fresh basis indicating more than very good acceptability. Verma *et al*. (2010) reported that substitution of 40 % sodium chloride with salt substitute blend along with incorporation of apple pulp (8 % to 12 %) resulted in significant decline in flavour scores due to mild sweet fruity flavour contributed by apple pulp.

Flavour scores decreased significantly ($P \leq 0.05$) in all the treatments with the advancement of storage days during refrigerated storage. This decrease in flavour might be

owing to microbial growth and oxidative rancidity with advancement in storage period (Devatkal *et al*., 2003). Flavour scores of all the treatments were comparable with both controls at the end of storage. Results indicate that 6 % DPP and DAPP treated rolls had less deterioration in flavour scores in comparison to controls during storage. This might be due to presence of natural antioxidants in DPP and DAPP which resulted in less oxidative deterioration in these treatments. The phenolic compounds present in dried plum products have been reported to impede oxidation of low density lipoprotein (Stacewicz-Sapuntzakis *et al*., 2001).

Texture: Texture scores ranged from 6.67 to 7.88 for fresh meat rolls. The control and control LS were comparable on 0 day as well as throughout the storage period in terms of texture scores(Table 4). Horita *et al*. (2011) did not notice any significant alteration between the treatments with lowered NaCl containing different mixtures of salt replacers and the control sample in terms of appearance, aroma and texture. Gou *et al*. (1996) observed no significant variations in the textural and flavour scores of fermented sausages up to 40 % NaCl substitution with either KCl or potassium lactate and calcium ascorbate combination.

The addition of DPP and DAPP in low salt meat rolls up to 4 % did not result in any significant difference in texture score. But further increase in DPP and DAPP at 6 % resulted in significant decline in texture scores in fresh meat rolls. This might be due to increase in hardness as fibre addition in meat products increases hardness (Fernandez-Gines *et al*., 2004). Substitution of 40 % NaCl with salt substitute blend along with addition of apple pulp resulted in significant decline in texture scores with the growing concentration of apple pulp (Verma *et al*., 2010). Significant decline was noticed in texture scores of both controls and treated meat rolls with increase in storage days. At the end of storage period of 15 days, texture scores of T_1, T_2, T_4, T_5 and T6 were comparable with respect to control and control LS and were well above 6.0 representing more than moderate desirability.

Juiciness: The scores for juiciness showed a range of 6.58 to 7.79 for fresh control and treated meat rolls (Table 5). Juiciness scores of control LS did not display any distinguished variation in comparison to full salt control during the whole period of refrigerated storage. No significant difference in juiciness scores of fresh meat rolls was noticed among both the controls and treated meat rolls up to 4 % fibre addition. Further increase in incorporation of each of DPP and DAPP at 6 % resulted in significant decline in juiciness of low salt rolls in comparison to control and control LS. The reduced moisture content in these treatments might have caused decline in their juiciness scores. Scores for juiciness declined progressively in all the samples with increase in storage days. Significant decrease in the juiciness scores was observed at the end of 15th day in both types of controls as well as low salt fibre treated meat rolls with respect to their fresh counterparts. This decrease in juiciness scores might due to loss of moisture during refrigerated storage in aerobic packaging. At the end of storage period, except treatment T3, juiciness scores of all the treatments were above 6.0 on 8 point descriptive scale.

Tenderness: Tenderness scores of full salt control, salt substituted control and low salt fibre treated meat rolls varied from 6.63 to 7.83 on 0 day of refrigerated storage(Table 6). The tenderness scores were comparable between control and control LS on day 0 as well as through out the storage period. The scores of tenderness for T1, T2, T4 and T5 did not show any significant difference in comparison to control and control LS on 0 day. Addition of DPP and DAPP at 6 % level resulted in significant decline in tenderness scores of low salt rolls with respect to both the controls. With the advancement of storage period, tenderness scores followed a decreasing trend irrespective of treatments. At the end of storage of 15 days, all treatments except T3 had comparable tenderness scores of more than 6.0 indicating moderately tender.

Overall acceptability: Overall acceptability (OAA) scores for full salt control, salt substituted control and treated meat rolls ranged from 6.63 to 7.83 on 0 day of storage(Table 7). No significant difference in OAA scores of control and control LS was noticed on day 0 as well as during storage at refrigerated temperature. The fresh low salt meat rolls containing 2 % and 4 % of DPP and DAPP individually did not show significant variation in comparison to full salt control and salt substituted control. Scores for these treatments were above 7.0 indicating very good acceptability on 0 day. OAA scores for treatments T3 and T6 containing 6 % DPP and 6 % DAPP each were significantly ($P \leq 0.05$)lower than both types of controls. Lower OAA scores for T3 and T6 were due to their lower flavour, texture, juiciness and tenderness scores. The consumers were not able to recognize the alterations in sensory attributes on reduction of sodium chloride up to 25 % in frankfurters sausages during storage (Tobin *et al*., 2013). Verma *et al*. (2010) demonstrated that replacement of 40 % sodium chloride with salt substitute blend and further incorporation of apple pulp resulted in significant decrease in OAA scores in comparison to control.

OAA scores decreased significantly ($P \leq 0.05$) in all the treatments with advancement in storage period. On 15th day, OAA scores were in the range of 5.79 to 6.67. Decrease in scores for other sensory attributes resulted in a decrease in OAA scores during refrigerated storage. Except T3, no significant difference in OAA was noticed among different treatments and score were well above 6.0 indicating moderate acceptability at the end of refrigerated storage.

Table 2: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on colour and appearance scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days Treatments	0	3	6	9	12	15
Control	7.83^{aA}±0.40	7.75^{aAB}±0.34	7.50^{aABC}±0.43	7.29^{abBC}±0.45	7.08^{aCD}±0.47	6.79^{aD}±0.40
Control LS	7.83^{aA}±0.25	7.71^{aAB}±0.40	7.50^{aABC}±0.48	7.33^{aBC}±0.39	7.08^{aCD}±0.29	6.79^{aD}±0.33
	Dried plum powder (DPP) incorporated low salt meat rolls					
T1	7.79^{aA}±0.33	7.67^{aAB}±0.44	7.42^{abABC}±0.47	7.17^{abBCD}±0.57	6.96^{aCD}±0.54	6.71^{aD}±0.45
T2	7.58^{abA}±0.47	7.50^{abA}±0.52	7.29^{abAB}±0.58	7.08^{abABC}±0.47	6.92^{aBC}±0.36	6.63^{aC}±0.40
T3	7.17^{bA}±0.39	7.08^{bAB}±0.51	6.88^{bABC}±0.31	6.71^{bABC}±0.45	6.58^{aBC}±0.47	6.42^{aC}±0.51
	Dried apple pomace powder (DAPP) incorporated low salt meat rolls					
T4	7.79^{aA}±0.40	7.71^{aA}±0.45	7.46^{abAB}±0.50	7.29^{abABC}±0.40	7.04^{aBC}±0.62	6.79^{aC}±0.58
T5	7.67^{abA}±0.49	7.58^{abA}±0.47	7.38^{abAB}±0.48	7.17^{abABC}±0.39	7.00^{aBC}±0.37	6.75^{aC}±0.50
T6	7.42^{abA}±0.47	7.33^{abAB}±0.44	7.17^{abABC}±0.44	6.96^{abABC}±0.54	6.83^{aBC}±0.44	6.63^{aC}±0.48

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

Table 3: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on flavour scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days Treatments	0	3	6	9	12	15
Control	7.83^{aA}±0.44	7.71^{aA}±0.45	7.33^{aAB}±0.44	6.88^{aBC}±0.31	6.42^{aCD}±0.47	6.29^{aD}±0.40
Control LS	7.71^{aA}±0.45	7.58^{aA}±0.47	7.21^{abAB}±0.40	6.75^{aBC}±0.40	6.29^{aCD}±0.45	6.17^{aD}±0.39
	Dried plum powder (DPP) incorporated low salt meat rolls					
T1	7.58^{abA}±0.47	7.42^{abA}±0.42	7.08^{abAB}±0.51	6.67^{abBC}±0.44	6.25^{aC}±0.40	6.13^{aC}±0.48
T2	7.33^{abcA}±0.54	7.21^{abcA}±0.40	6.92^{abcAB}±0.29	6.54^{abBC}±0.45	6.21^{aC}±0.58	6.08^{aC}±0.51
T3	6.79^{cA}±0.50	6.75^{cA}±0.50	6.50^{cAB}±0.52	6.17^{bABC}±0.58	5.92^{aBC}±0.51	5.83^{aC}±0.58
	Dried apple pomace powder (DAPP) incorporated low salt meat rolls					
T4	7.71^{aA}±0.45	7.54^{abA}±0.45	7.25^{abAB}±0.45	6.79^{aBC}±0.40	6.38^{aC}±0.43	6.33^{aC}±0.54
T5	7.50^{abA}±0.52	7.38^{abA}±0.48	7.08^{abAB}±0.51	6.71^{abBC}±0.40	6.33^{aC}±0.50	6.21^{aC}±0.58
T6	7.04^{bcA}±0.54	6.96^{bcAB}±0.54	6.71^{bcABC}±0.45	6.38^{abBC}±0.57	6.13^{aC}±0.61	6.08^{aC}±0.56

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

Table 4: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on texture scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days Treatments	0	3	6	9	12	15
Control	7.88^{aA}±0.31	7.75^{aA}±0.50	7.58^{aA}±0.47	7.38^{aAB}±0.48	7.00^{aBC}±0.37	6.67^{aC}±0.44
Control LS	7.67^{aA}±0.44	7.54^{aA}±0.45	7.38^{aAB}±0.48	7.17^{abAB}±0.44	6.83^{abBC}±0.44	6.54^{aC}±0.45
Dried plum powder (DPP) incorporated low salt meat rolls						
T1	7.63^{aA}±0.48	7.50^{aA}±0.48	7.33^{aAB}±0.44	7.13^{abAB}±0.38	6.83^{abBC}±0.44	6.54^{aC}±0.45
T2	7.42^{abA}±0.51	7.33^{abA}±0.44	7.21^{abAB}±0.40	7.08^{abAB}±0.51	6.75^{abBC}±0.50	6.46^{abC}±0.50
T3	6.67^{cA}±0.44	6.58^{cA}±0.51	6.46^{cAB}±0.50	6.33^{cAB}±0.49	6.13^{cAB}±0.60	5.88^{bB}±0.53
Dried apple pomace powder (DAPP) incorporated low salt meat rolls						
T4	7.67^{aA}±0.49	7.54^{aA}±0.50	7.42^{aAB}±0.51	7.25^{aAB}±0.40	6.96^{abBC}±0.45	6.67^{aC}±0.49
T5	7.50^{aA}±0.52	7.42^{abAB}±0.47	7.33^{aAB}±0.44	7.21^{aAB}±0.58	6.87^{abBC}±0.53	6.58^{aC}±0.47
T6	6.92^{bcA}±0.29	6.83^{bcA}±0.39	6.71^{bcA}±0.45	6.58^{bcAB}±0.56	6.38^{bcAB}±0.48	6.13^{abB}±0.61

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

Table 5: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on juicness scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days Treatments	0	3	6	9	12	15
Control	7.79^{aA}±0.40	7.71^{aA}±0.45	7.54^{aA}±0.50	7.33^{aAB}±0.49	6.96^{aBC}±0.33	6.63^{aC}±0.43
Control LS	7.58^{aA}±0.47	7.50^{aA}±0.48	7.33^{aAB}±0.44	7.13^{abAB}±0.53	6.79^{aBC}±0.40	6.42^{aC}±0.42
Dried plum powder (DPP) incorporated low salt meat rolls						
T1	7.54^{aA}±0.45	7.46^{aA}±0.45	7.29^{aA}±0.45	7.08^{abAB}±0.36	6.75^{aBC}±0.45	6.46^{aC}±0.50
T2	7.42^{abA}±0.47	7.33^{abA}±0.44	7.17^{abAB}±0.39	7.00^{abAB}±0.43	6.67^{abBC}±0.49	6.42^{aC}±0.56
T3	6.58^{cA}±0.51	6.46^{cAB}±0.50	6.33^{cABC}±0.54	6.21^{cABC}±0.50	5.96^{cBC}±0.54	5.75^{bC}±0.50
Dried apple pomace powder (DAPP) incorporated low salt meat rolls						
T4	7.58^{aA}±0.51	7.50^{aA}±0.48	7.33^{aA}±0.44	7.13^{abAB}±0.31	6.79^{aBC}±0.40	6.50^{aC}±0.52
T5	7.50^{abA}±0.52	7.42^{abA}±0.47	7.25^{abAB}±0.45	7.08^{abAB}±0.51	6.75^{aBC}±0.45	6.50^{aC}±0.48
T6	6.92^{bcA}±0.36	6.83^{bcA}±0.44	6.71^{bcA}±0.45	6.58^{bcAB}±0.51	6.13^{bcBC}±0.31	6.04^{abC}±0.50

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

Table 6: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on tenderness scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days / Treatments	0	3	6	9	12	15
Control	7.83^{aA}±0.33	7.75^{aA}±0.45	7.58^{aA}±0.51	7.33^{aAB}±0.44	7.04^{aBC}±0.45	6.71^{aC}±0.45
Control LS	7.67^{aA}±0.44	7.58^{aA}±0.47	7.50^{aA}±0.48	7.21^{aAB}±0.58	6.88^{abBC}±0.31	6.54^{aC}±0.45
Dried plum powder (DPP) incorporated low salt meat rolls						
T1	7.58^{aA}±0.47	7.50^{aA}±0.48	7.33^{aAB}±0.44	7.13^{abAB}±0.43	6.83^{abBC}±0.39	6.54^{aC}±0.50
T2	7.46^{aA}±0.50	7.38^{abA}±0.43	7.21^{aAB}±0.40	7.04^{abABC}±0.45	6.75^{abBC}±0.45	6.50^{aC}±0.56
T3	6.63^{bA}±0.48	6.54^{cA}±0.50	6.38^{bAB}±0.57	6.25^{cAB}±0.50	6.00^{cAB}±0.56	5.83^{bB}±0.54
Dried apple pomace powder (DAPP) incorporated low salt meat rolls						
T4	7.63^{aA}±0.48	7.54^{aA}±0.50	7.38^{aAB}±0.48	7.17^{aAB}±0.39	6.88^{abBC}±0.43	6.58^{aC}±0.47
T5	7.54^{aA}±0.50	7.46^{aA}±0.50	7.29^{aAB}±0.45	7.13^{abABC}±0.53	6.83^{abBC}±0.39	6.58^{aC}±0.51
T6	6.96^{bA}±0.45	6.88^{bcA}±0.53	6.71^{bAB}±0.45	6.58^{bcAB}±0.51	6.33^{bcAB}±0.62	6.17^{abB}±0.58

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

Table 7: Effect of dried plum powder (DPP) and dried apple pomace powder (DAPP) incorporation on overall acceptability (OAA) scores of low salt buffalo calf meat rolls packaged in aerobic conditions and stored at 4±2°C (Mean±SD, n=12)

Storage days / Treatments	0	3	6	9	12	15
Control	7.83^{aA}±0.39	7.75^{aA}±0.50	7.58^{aA}±0.47	7.38^{aAB}±0.43	7.00^{aBC}±0.37	6.67^{aC}±0.44
Control LS	7.63^{aA}±0.48	7.54^{aA}±0.45	7.38^{aA}±0.48	7.17^{abAB}±0.39	6.83^{abBC}±0.39	6.46^{aC}±0.45
Dried plum powder (DPP) incorporated low salt meat rolls						
T1	7.58^{aA}±0.47	7.50^{aA}±0.48	7.33^{aAB}±0.44	7.13^{abAB}±0.38	6.79^{abBC}±0.50	6.50^{aC}±0.52
T2	7.46^{aA}±0.45	7.38^{aA}±0.48	7.21^{abAB}±0.58	7.04^{abABC}±0.45	6.71^{abBC}±0.45	6.46^{aC}±0.58
T3	6.63^{bA}±0.43	6.50^{bA}±0.42	6.38^{cAB}±0.48	6.25^{cAB}±0.62	6.00^{cAB}±0.60	5.79^{bB}±0.45
Dried apple pomace powder (DAPP) incorporated low salt meat rolls						
T4	7.63^{aA}±0.48	7.54^{aA}±0.45	7.38^{aA}±0.48	7.17^{abAB}±0.39	6.83^{abBC}±0.44	6.54^{aC}±0.45
T5	7.54^{aA}±0.50	7.46^{aA}±0.50	7.29^{aAB}±0.45	7.13^{abAB}±0.53	6.79^{abBC}±0.40	6.54^{aC}±0.50
T6	6.92^{bA}±0.51	6.83^{bA}±0.58	6.75^{bcAB}±0.45	6.63^{bcAB}±0.57	6.25^{bcAB}±0.62	6.13^{abB}±0.64

Means with different small letter superscripts in a column and capital letter superscripts in a row differ significantly (P≤0.05)

Control- meat rolls without salt substitute and without fibre source, Control LS- meat rolls with salt substitute and without fibre source, T1- meat rolls with salt substitute and with 2 % DPP (dried plum powder) incorporation, T2- meat rolls with salt substitute and with 4 % DPP (dried plum powder) incorporation, T3- meat rolls with salt substitute and with 6 % DPP (dried plum powder) incorporation, T4- meat rolls with salt substitute and with 2 % DAPP (dried apple pomace powder) incorporation, T5- meat rolls with salt substitute and with 4 % DAPP (dried apple pomace powder) incorporation, T6- meat rolls with salt substitute and with 6 % DAPP (dried apple pomace powder) incorporation

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