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# Effect of Tapioca Starch on Physico-Chemical and Sensory Characteristics of Buffalo Meat Sausage

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**Abstract:** A study on the determine the optimum level of inclusion of 3 different levels tapioca starch (3, 7 and 10%) in buffalo meat sausage incorporated with 30% less value meat was carried out. The optimum level of tapioca starch was determined by assessing the physico-chemical (emulsion pH, product pH, emulsion stability, cooking yield and shear force value) and sensory characteristics. A highly significant ($p<0.01$) increase in emulsion and product pH was observed with increase in level of inclusion. Similarly, 10% tapioca starch recorded better emulsion stability and cooking yield compared to other levels.

**Key words:** Buffalo sausage, tapioca flour, emulsion, sensory evaluation, refrigerated storage, India

## INTRODUCTION

India ranks first in the world buffalo population (96.9 million) and possess about 58% of world population. Buffalo meat has several good attributes such as high protein content, low fat and cholesterol content as well as low calories in comparison to beef. It has good functional properties for processing into variety of meat products (Murthy and Devadason, 2003).

Although, buffalo meat is rated superior to beef the meat from aged buffalo is not preferred because of its toughness. Utilization of tough meat like head meat and other offal meat in the production of value added comminuted meat products will promote the meat industry. Buffalo meat has been used for processing of products like sausages (Sachindra *et al*., 2005), patties (Suman and Sharma, 2003) and nuggets (Thomas *et al*., 2006).

These offal meat and low value cuts are low in emulsifying and water binding capacities (Hendrick *et al*., 1994; Whiting, 1989). Binders especially those of plant origin can be used in the product formulations to compensate low functionality of such meat and offals (Bawa *et al*., 1998). Tapioca has long been used by meat processors and can be processed into starches and flour which can be used in sausages as binder or extender to increase water binding and improve cooking yield (Hughes *et al*., 1998). Hence, this study has been designed to evaluate the optimum level of inclusion of tapioca starch as a binder in improving the stability of buffalo meat sausage.

## MATERIALS AND METHODS

Fresh buffalo lean meat, head meat, heart, tongue and fat were obtained from the buffaloes slaughtered at the Chennai corporation slaughter house, perambur. Meat from head and cheek was isolated and separable fat was removed. Heart was cut open along its longitudinal axis and clotted blood was removed. The epithelial layer of tongue was scrapped off and then cut into small pieces. The lean meat, head meat, tongue, fat and heart were packed in polyethylene bags separately and frozen at -20°C. Commercially available tapioca starch was utilized in the present study.

**Preparation of sausage:** Sausages were prepared by using 50% lean meat, 30% low value meat (LVM-head, heart and tongue), 20% fat and with 3, 7 and 10% levels of tapioca starch individually. Frozen meat, LVM and fat were tempered at 4°C and were cut into small pieces and minced using 4.5 mm plate in Electrolux mincer (Omas, Model-16789). LVM was minced twice.

Additives (Sodium tripolyphosphate-0.3%, salt-2% and Sodium nitrite-120 ppm), spice mix-1.5%, green condiments, chilled water (Ice)-10% were added and chopped along with meat and fat in a meat chopper. At the final step tapioca starch was added and chopped for 1.5 min. During chopping care was taken to maintain the emulsion temperature between 10-13°C. From this emulsion samples were taken for pH and emulsion stability. Sausage emulsion was stuffed in sheep casing of 19 mm diameter, using a manual sausage stuffer and

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linked manually. Stuffed sausages were kept in refrigerator (4±1°C) for 1 h to ensure proper setting. Sausages were then cooked in water bath at 80°C for 15 min until a core temperature of 72±3°C was reached. Sausages prepared were subjected to physicochemical and sensory evaluation.

**Analysis:** The pH was measured using a digital pH meter (Cyberscan pH 510, Merck). Emulsion stability was estimated as per the method outlined by Baliga and Madaiah (1971). The cooking yield was calculated as difference in the weight of sausage before and after cooking. The shear force values of cooked sausages were assessed using Warner Bratzler Shear Press (Model No. 04347, The G.R. MFG. Co., Manhattan, USA).

Thio-Barbituric Acid Reactive Substance (TBARS) number and Tyrosine Value (TV) were determined using method of Tarladgis *et al.* (1960) and Strange *et al.* (1977), respectively. Organoleptic quality was evaluated by semi-trained panel using a 9 point hedonic scale (where 9 was extremely desirable and 1 was extremely undesirable).

**Statistical analysis:** Data were analyzed by statistical method of one way ANOVA using SPSS@ software package developed as per the procedure of Snedecor and Cochran (1994) and means were compared by using Duncan's multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

The mean values on physicochemical and sensory characteristics of buffalo meat sausages with different levels of inclusion of tapioca are shown in Table 1 and 2. The pH of both emulsion and product showed a highly significant ($p<0.01$) increase with increase in levels of tapioca. The pH of emulsion increased irrespective of the levels of inclusion, upon cooking which might be attributed to the fact that in the cooking range of 55-80°C new cross linkages are formed along with loss of free acidic groups from meat protein (Reddy and Vijayalakshmi, 1998). A highly significant ($p<0.01$) enhancement in emulsion stability was observed in sausages incorporated with 7 and 10% levels tapioca. This might be attributed to high starch content of TS and binding of more amount of water favoring stable emulsion formation (Berry and Wergin, 1993). A highly significant ($p<0.01$) increase was observed in shear force with increase in levels of tapioca.

Carballo *et al.* (1996) established a direct relationship between starch content and hardness of frankfurters. Addition of starch generally caused an increase in penetration force (Hughes *et al.*, 1998). This may be due to the fact that starch favours formation of strong heat induced structure through swelling of starch granules embedded in protein matrix (Berry and Wergin, 1993).

Table 1: Mean±SE values of physico-chemical characteristics of buffalo meat sausage with different levels of tapioca starch

| | Levels of tapioca starch | | |
|---|---|---|---|
| Parameters | 3% | 7% | 10% |
| Emulsion pH | 5.71±0.010$^a$ | 5.76±0.01$^b$ | 5.83±0.01$^c$ |
| Product pH | 5.76±0.007$^a$ | 5.84±0.01$^b$ | 5.90±0.01$^c$ |
| Emulsion stability (%) | 95.54±0.360$^a$ | 98.01±0.24$^b$ | 98.95±0.14$^c$ |
| Cooking yield (%) | 95.66±0.210$^a$ | 97.59±0.29$^b$ | 98.60±0.18$^c$ |
| Shear force (kg/19 mm dia) | 0.47±0.010$^a$ | 0.54±0.01$^b$ | 0.61±0.01$^c$ |

Means bearing different superscripts (a-c) between rows differ significantly ($p<0.01$ or $p<0.05$)

Table 2: Mean±SE values of sensory characteristics of buffalo meat sausage with different levels tapioca starch

| | | Levels of tapioca starch | | |
|---|---|---|---|---|
| Parameters | n | 3% | 7% | 10% |
| Appearance | 6 | 6.86±0.29$^a$ | 7.26±0.24$^a$ | 6.78±0.32$^a$ |
| Flavour | 6 | 7.13±0.10$^a$ | 7.04±0.27$^a$ | 6.21±0.30$^b$ |
| Texture | 6 | 6.84±0.10$^a$ | 7.55±0.05$^b$ | 6.24±0.27$^c$ |
| Juiciness | 6 | 7.00±0.19$^a$ | 7.49±0.05$^b$ | 6.27±0.12$^c$ |
| Overall acceptability | 6 | 6.69±0.05$^a$ | 7.58±0.07$^b$ | 6.23±0.20$^c$ |

Means bearing different superscripts (a-c) between rows differ significantly ($p<0.01$ or $p<0.05$)

No significant ($p>0.05$) difference was observed in appearance scores of sausages with different levels of inclusion of tapioca starch. Flavour scores did not differ significantly ($p>0.05$) between 3 and 7% levels of tapioca starch but they differ highly significant ($p<0.01$) with 10% levels. Knight and Perkin (1991) reported an enhanced flavour release during mastication in sausages containing added tapioca starch and was possibly due to the ability of starch to slowly release bound water during physical breakdown at optimum levels, allowing more efficient flavour release. A highly significant ($p<0.01$) difference in texture scores was evident between different levels of tapioca starch.

Upon sensory evaluation, sausages with tapioca starch at 7% level showed highest texture score. Hughes *et al.* (1998) observed a similar improvement in hardness, gumminess and chewiness of frankfurters with addition of tapioca starch. A highly significant ($p<0.01$) difference in juiciness of sausages was observed with increase in levels of inclusion of tapioca starch. Sausages with 7% level had the highest juiciness scores followed by 3% level in tapioca starch. This was in agreement with Lyons *et al.* (1999) who observed that at higher levels of addition, tapioca starch had a negative effect on organoleptic scores for juiciness. Results revealed that sausages with 10% inclusion level recorded better Emulsion stability and cooking yield followed by 7 and 3% levels. The sensory scores revealed sausages with 7% level had higher scores than 10 and 3%. Hence, tapioca

Table 3: Mean±SE for physico-chemical characteristics of buffalo meat sausage with 7% tapioca starch at refrigerated storage (4±1°C)

| | Storage days | | | | | |
|---|---|---|---|---|---|---|
| Parameters | 0 | 7 | 14 | 21 | 30 | Mean±SE |
| pH | 5.81±0.020 | 5.92±0.010 | 6.13±0.020 | 6.25±0.01 | 6.07±0.018 | 6.04±0.02$^{NS}$ |
| Shear force value | 0.53±0.010$^{a}$ | 0.70±0.010$^{b}$ | 0.86±0.007$^{c}$ | 0.96±0.01$^{d}$ | 1.11±0.007$^{e}$ | 0.83±0.01** |
| TBARS (mg of malanoldehyde/kg) | 0.45±0.008$^{a}$ | 0.76±0.008$^{b}$ | 0.85±0.010$^{c}$ | 0.93±0.01$^{d}$ | 1.07±0.020$^{e}$ | 0.81±0.01** |
| Tyrosine value (mg/100 g of sample) | 1.54±0.050$^{a}$ | 3.51±0.250$^{b}$ | 4.61±0.180$^{c}$ | 6.25±0.14$^{d}$ | 8.55±0.090$^{e}$ | 4.89±0.15** |

Means bearing same superscripts (a-e) between rows do not differ significantly ($p<0.01$ or $p<0.05$); **Highly significant ($p<0.01$)

starch at 7% level was considered optimum in preparation of buffalo meat sausage with 70% lean meat and 30% low value meat. The mean values on physicochemical characteristics of sausages with optimum level (7%) of TS at refrigerated storage (4±1°C) are shown in Table 3. A highly significant ($p<0.01$) increase in pH values was observed from 0-20 days of storage and a slight decrease at 30 days of storage.

This is in congruence with Reddy and Rao (2000) who observed increase in pH with increase in storage period in patties. They attributed that the increase in storage might be due to liberation of metabolites resulting from bacterial activity. Shear force values showed a highly significant ($p<0.01$) increase during storage period. Similar findings were observed by Thompson, Sahoo and Anjaneyulu (1997) who suggested that increase in firmness could have been caused by dehydration of cooked sausages.

There was a progressive increase ($p<0.01$) in TBARS number during storage which is in concurrence with Bentley *et al.* (1987) and is a reflection of the advance in oxidative changes in buffalo meat sausage during storage. Tyrosine value showed a linear and highly significant ($p<0.01$) increase with the increase in storage days from an initial value and was in accordance with findings of Bentley *et al.* (1987).

Sausages prepared with 7% inclusion of tapioca starch were acceptable till 21 days of storage at refrigerated temperature and their stability were based on the rancidity and protein degradation.

## CONCLUSION

Sensory evaluation revealed that sausages prepared with 7% tapioca starch had superior scores ($p<0.01$) compared to 3 and 10%. Sausages with 7% level had higher scores for appearance, texture, flavour, juiciness and overall palatability. Sausages prepared with 7% level of TS were packed and stored at refrigeration (4±1°C) for 30 days.

The product was subjected to storage stability studies based on evaluation of pH, shear force, TBARS and Tyrosine value. The results revealed that during storage there was a highly significant ($p<0.01$) decrease in pH and shear force value and significant increase in TBARS and TV value. Sausages prepared with 7% PF were acceptable upto 21 days of refrigerated storage.

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