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RESEARCH ARTICLE

STORAGE STABILITY OF LOW FAT GOSHTABA INCORPORATED WITH SODIUM ALGINATE AS FAT REPLACER.

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Abstract

A study was conducted with an objective to evaluate the effect of sodium alginate @ 0.1% (on weight basis) of batter on the refrigerated storage quality of low fat *Goshtaba*. The cooked product along with the gravy was aerobically packaged in low density polyethylene bags and stored at $4\pm 1^{\circ}\text{C}$ for a period of three weeks during which the product samples were drawn at weekly intervals and evaluated for pH, Thiobarbituric acid value, microbiological quality and sensory attributes. The results indicated that the pH and Thiobarbituric acid value of *Goshtaba* samples increased significantly ($P < 0.05$) with the advancement of storage. However, the values even at the end of storage period were well within the reported safe limits and not indicative of any rancidity. No coliforms were detected in the study. The total plate counts were low and acceptable even at the end of storage period. The results of sensory evaluation revealed a gradual decrease in the scores of various attributes with the advancement of storage. However, the scores even at the end of storage period remained generally in the range of above six indicating good acceptability of the product. It was concluded that incorporation of sodium alginate @ 0.1%, in *Goshtaba* could be one of the alternatives to address the problem of high fat with beneficial effects on quality and storage stability

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Introduction:-

Modern trend towards convenience foods has resulted in increased consumption of restructured meat products and are of great importance to the meat industry. Fats are of vital importance as a source of energy and as carriers of fat soluble vitamins. In meat products fat also plays an important role in stabilizing meat emulsions, reducing cooking loss, improving water holding capacity and providing juiciness and hardness (Yoo *et al.*, 2007). However, high fat contents in particular animal fats provide high amounts of saturated fatty acids and cholesterol. High animal fat diets are associated with several types of ailments like obesity, hypertension, cardiovascular diseases and coronary heart diseases (McAfee *et al.*, 2010). Oxidation of lipids and proteins poses serious health risks besides being a major threat to meat quality. The onset of oxidative reactions in muscle foods during handling, processing and storage leads to undesirable sensory changes and deterioration of nutritive value. A deterioration of nutritive value may be a consequence of interactions between lipid oxidation products and protein (Hes *et al.*, 2012). Thus fat reduction has generally been seen as an important strategy to improve the fat content of foods and produce healthier products. This

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aspect is especially relevant to the meat industry since some meat products contain high proportions of fat. The state of Jammu and Kashmir in India is widely known for wazwan which a combination is of restructured traditional meat products viz *kabab*, *rista*, *goshtaba* and the like.

Goshtaba forms the essential component of Kashmiri wazwan. This is a ground meat product prepared from a meat emulsion. Considerable amount of animal fat (20%) is used in the formulation to achieve a stable emulsion, and also to impart a special taste and flavor to the product (Heena *et al.*, 2014). Thus there is great scope and need for improvements over the traditional practices followed in its formulation, preparation and preservation so as to enhance its quality as well as shelf life and thus safeguard the health of consumers. Low fat meat products are in great demand as they have been perceived as more healthy by consumers. However there are many problems concerning the acceptance of these products, for example when the fat levels are lowered the products become firmer, more rubbery, less juicy, darker in color, costly and less acceptable in terms of skin formation, mouth feel, processing yield, and increased purge in vacuum packaging (Youssef and Barbut, 2011). Hence manufacturers have introduced several modifications in an attempt to offset the detrimental effects of fat reduction. They include the use of non-meat ingredients to improve the texture and the water holding capacity and/or the adaptation of procedures to modify the composition of final products (Garcia *et al.*, 2002).

Hydrocolloid gums due to its high binding and gelling property are extensively used as binder in meat products. Alginates are polysaccharides extracted from anionic red or brown seaweed, *Phaeophycase* and also from giant kelp *Macrocystis pyrifera* (Pomini, 1973). These are linear polymer of D-mannuronic acid and linear polymer of D-mannuronic acid and L- guluronic acid. It is used as sodium or calcium salt in the food system. Various workers used alginates as thickening agent, binding agent, enrobing and as fat replacer (Kumar and Sahoo, 2006) in meat products. The objective of this study was to evaluate the effect of sodium alginate on the physicochemical properties, oxidative stability, microbiological and sensory quality of low fat mutton *Goshtaba*, a traditional meat product of Jammu and Kashmir, India.

Materials and Methods:-

Materials:-

Lean mutton and fat obtained from male lambs (6-9 months of age), was purchased from the local market and used for the preparation of the products within 2 hours of slaughter. Dry spices, Leek (*Allium cepa var. viviparum*), ready-to-use Garlic (*Lehsan*) paste, fresh curd of desired consistency, table salt, vegetable oil and oat flour were purchased from local market.

Experimental design:-

The products were prepared following the standardized procedure of Heena *et al* (2014) with slight modifications. The general formulation of *Goshtaba* was: Boneless mutton-90%, mutton fat-10%, common salt-2.50%, chilled water/ice flakes-10% and large cardamom seeds-0.20%. The basic formulation, without any modification, served as control (T₀) and batter supplemented with sodium alginate @ 0.1% served as Treatment-1 (T₁).

Product Preparation:-

Meat emulsion was prepared by pounding hot boned meat manually on a flat and smooth stone called “*Maz-Kaene*” (*Maz*-meat; *Kaene*-stone) with a wooden hammer called “*Goshpare*” (*Gosh*-meat; *Pare*-hammer) along with mutton fat, first individually and then in combination (Heena *et al.* 2014). Common salt and large cardamom seeds were added to it during beating. Periodical sprinkling of chilled water up to a predetermined level was done. Pounding of meat was continued until a proper dispersion of the lean and fat was obtained and the emulsion exhibited a characteristic cohesiveness, binding and fluidy consistency, traditionally called as “*Macchwor*”. After addition of the sodium alginate the emulsion was further subjected to pounding to ensure uniform mixing of fat replacer. The raw emulsion (1.0 kg) was then moulded in the shape of spherical balls (20*50g each) and kept in refrigerator until gravy preparation.

For preparing gravy (*Yakhni*), two parts of fresh curd was homogenized with 1 part of water (by weight) with a stirrer, transferred to a thick bottomed stainless steel vessel and heated rapidly over high heat on a gas stove for 10-15 min. During heating curd was constantly stirred until it reached the boiling point. Hydrogenated vegetable oil was added to it and boiling continued for 10 min. Then garlic paste was added followed by other spices i.e. large cardamom, small cardamom, cinnamon, cloves, dried ginger powder and aniseed powder respectively. Fried leek paste was added at the end. Boiling was continued until the added oil floated back. At this stage, the remaining water

was added and *Yakhni* was cooked further for 10-15 min. to obtain a desirable consistency. The meat balls reshaped and removed from the refrigerator, were transferred to the boiling *Yakhni* and cooked for 30 min.

Analytical procedures:-

pH

The pH was determined by following the method of Keller *et al.* (1974). Meat emulsions were measured in a homogenate prepared with 5 g of sample and distilled water (20 mL) using a pH meter (Model CP 901, Century Instruments Ltd., India). All determinations were performed in triplicate.

Microbiological examination:-

Microbiological profile viz. total plate count, coliform count and yeast and mould count in the samples were determined by methods described by Maturin and Peeler (2001), Feng *et al.* (2002) and Tournas *et al.* (2001) respectively. Readymade media (Hi-Media) were used for the analysis. Ten grams of sample was taken in a presterilized pestle and mortar mixed properly with 90 mL of 0.1% sterile peptone water. Serial 10-fold dilutions were made with peptone water (0.1%). Preparation of sample and serial dilutions were done near a flame in a laminar flow apparatus (Thermo Electron Corporation. D-63505 Langenselbold, Robert Boschstr. 1, Germany) observing all possible aseptic conditions.

Total plate count:-

Twenty-three and half grams of plate count agar was suspended in 1000 mL of distilled water followed by boiling to dissolve the media completely and sterilization by autoclaving at 15 lbs of pressure (121 °C) for 15 min. About 20 mL of the sterilized medium was used for each sterile petri dish and pour plate technique was used for determining the total aerobic mesophilic count in sample. Plates were incubated at 35 °C for 48 h. Colonies were counted using an electronic colony counter. The average number of colonies were multiplied by the reciprocal of the dilution and expressed as log₁₀ colony forming units (cfu)/g of sample.

Coliform count:-

41.5 g of Violet Red Bile Agar obtained from Hi-Media Laboratories Pvt. Ltd., Mumbai (code No.M091) was suspended in one litre of distilled water, boiled to dissolve the medium completely and cooled to 45°C. The final pH was adjusted to 7.4±0.2 at 25°C. Pour plate with overlay techniques was followed for inoculation of suitable sample dilution and the plates were incubated at 35°±2°C for 24 h. The colonies were counted and results were expressed as log 10 cfu/g of sample.

Yeast and mould count:-

A quantity of 39g of Potato Dextrose Agar (Hi-media Laboratories Pvt. Limited, Mumbai) was suspended in 1 litre of distilled water, boiled to dissolve the medium completely and sterilized by autoclaving at 15 lbs pressure (121°C) for 15 minutes. The pH of sterilized medium was set to 3.5 by acidifying with 10 ml of 10% tartaric acid. Precaution was taken not to heat the medium after addition of the acid. Pour plate technique was followed for inoculation and plates were incubated at 25°C for 5 days. Colonies appearing on the plates were counted and expressed as log₁₀cfu/g.

Lipid oxidation (TBARS):-

Oxidative stability was evaluated by changes in thiobarbituric acid reactive substances (TBARS). The estimation of TBARS value was done by following the method of Witte *et al.* (1970) with slight modifications. A 10g aliquot of the sample was triturated with 25 ml of pre-cooled 20% trichloroacetic acid (TCA) in 2M orthophosphoric acid solution for 2 minutes. The contents were then quantitatively transferred into a beaker by rinsing with 25 ml of chilled distilled water, well mixed and filtered through ash less Whatman filter paper No. 1 (GE Healthcare, U.K). A quantity of 3 ml of TCA extract (filtrate) was mixed with 3 ml of TBA reagent (0.005M) in duplicate test tubes and placed in a dark room for 16 hours. A blank sample was made by mixing 3 ml of 10% TCA and 3 ml of the TBA reagent. Absorbance (O. D.) was measured at fixed wavelength of 532 nm using UV-VIS spectrophotometer (HITACHI, UV-Spectrophotometer U-1800, Japan). The TBARS value was calculated as mg malonaldehyde per kg of sample by multiplying O.D. value with k factor 5.2.

Sensory quality:-

Sensory evaluation was conducted according to the testing procedures of Seman *et al.* (1987) Samples were served in random order at temperature of approximately 60°C. A trained 10-member taste panel consisting of researchers

and faculty members from the Division of Livestock Products Technology, F.V.Sc. & A.H. Shuhama, were asked to express their opinion of the product. Samples were evaluated for firmness, flavor intensity, juiciness, and overall palatability using a nine-point hedonic scale. Each attribute was discussed and tests were initiated after panelists were familiarized with the scales. Each sample was coded with a randomly selected three-digit number and served in a white paper plate. Panelists were instructed to cleanse their palates between samples using cold water.

Statistical analysis:-

The data obtained from three replications were analyzed by ANOVA. Duncan's Multiple Range test and critical difference were determined at 5% significance level using SPSS-version 17.0.

Results and Discussion:-

Physico-chemical characters:-

The mean values of various physico-chemical characteristics of aerobically packaged cooked and control *Goshtaba* balls are presented in Table 1.

pH:-

The pH gradually increased during aerobic storage probably because of accumulation of bacterial metabolites and deamination of proteins. Karwowska and Dolatowski (2007) reported that the pH values of meat products with the addition of 2% and 5% oat were significantly higher after 1 and 15 days of storage period than the pH values noted for the control product and the product with 0.05% sodium ascorbate which was in agreement with our findings. Kumar *et al.* (2007) also observed that low-fat ground pork patties with 0.1% sodium alginate remain stable without any appreciable change in pH during aerobic refrigerated storage ($4\pm 1^\circ\text{C}$) for 21 days.

Lipid oxidation (TBARS):-

The overall mean Thiobarbituric acid reactive species (TBARS) value of T_1 remained significantly lower ($P < 0.05$) than that of T_0 during entire storage period. Increased TBA value during refrigerated and frozen storage of meat and meat products has been reported by Rajkumar *et al.* (2004). TBA values were low initially and remained low throughout the entire period of storage. Thus, the TBA values in the present study have never exceeded the values expected to produce off odors and off-flavors. This was in agreement with Kumar *et al.* (2007).

Total Plate count:-

The overall mean total plate count (TPC) of T_1 remained significantly lower than that of T_0 during the entire storage period of 20 days. Viudu *et al.* (2010) reported that the incorporation of orange dietary fibre in bologna sausage stored in vacuum packaging showed lower TPC than control. Similar results were obtained by Verma *et al.* (2010) in low fat chicken nuggets containing apple pulp.

Coliform counts:-

The test samples did not reveal any counts of coliform organisms during the period of storage. Coliforms were not detected in any sample during the entire storage period which might be due to better hygienic practices and high temperature treatment during cooking.

Yeast and moulds count:-

The yeast and mould counts were detectable only on day '10' and the counts on day '20' were significantly higher than the counts at day '15'. However, even on day '20' counts were quite acceptable and very well below the threshold limits indicative of even initial spoilage changes. This might be due to more acidic nature of *Goshtaba* Yakhni (containing curd) which may have favored the growth of fungi (Yeast and moulds) as these are more acid tolerant. Yeast and mould counts were not detected during early period of storage study which could be due to thorough cooking, good hygiene and absence of post processing contamination.

Sensory quality:-

The scores for sensory attributes tended to decrease as the storage period advanced. During refrigerated storage a gradual non-significant decrease in the appearance scores was observed (Table-1). Gazalli *et al.* (2016) also observed a decrease in appearance score in mutton nuggets extended with carrot powder under refrigerated storage. Karwowska and Dolatowski (2007) reported that oat-supplemented products were characterized by a lower degree of lipid oxidation, a lower redox potential and more stable color in reference to the control product (without oat supplement). A gradual decrease in the flavor and juiciness scores was observed. Verma *et al.* (2010) reported that

flavor scores of both control and low fat chicken nuggets containing apple pulp decreased gradually with increase in storage period. No-significant differences between T_1 and T_0 in the overall mean scores for texture, mouth coating and overall palatability were observed. In general, the scores for sodium alginate formulated low fat *Goshtaba* were higher than the control. Our result was in agreement with the findings of Kumar and Sharma (2004), who reported that low fat buffalo meat balls mixed with gravy and stored under refrigeration in LDPE up to 15 days, maintained very good acceptability. It was concluded that the incorporation of 0.1% sodium alginate as fat replacer in low fat *Goshtaba* could be one of the alternatives to address the problem of high fat without any adverse changes in its quality and storage stability.

Table 1:- Effect of refrigerated storage and sodium alginate on physico-chemical, microbiological and sensory characteristics of low fat *Goshtaba*.

Treatments*	Storage period (days)					Overall
	0	5	10	15	20	
pH						
T_0	5.31 ^{ab} ± 0.02	5.32 ^a ± 0.03	5.51 ^{bb} ± 0.01	5.52 ^b ± 0.01	5.94 ^c ± 0.05	5.54 ^B ± 0.03
T_1	5.27 ^{aA} ± 0.01	5.31 ^a ± 0.01	5.42 ^{bA} ± 0.00	5.51 ^c ± 0.01	5.88 ^d ± 0.05	5.48 ^A ± 0.03
TBA (mg malonaldehyde/Kg)						
T_0	0.15 ^{ab} ± 0.01	0.15 ^{ab} ± 0.01	0.19 ^{bb} ± 0.01	0.19 ^b ± 0.01	0.27 ^{cb} ± 0.01	0.19 ^B ± 0.01
T_1	0.14 ^{aA} ± 0.01	0.14 ^{aA} ± 0.01	0.18 ^{bA} ± 0.01	0.19 ^c ± 0.01	0.25 ^{dA} ± 0.01	0.18 ^A ± 0.01
Total Plate Count (log₁₀cfu/g)						
T_0	1.91 ^{ab} ± 0.02	2.05 ^b ± 0.02	2.15 ^{cb} ± 0.02	2.25 ^{db} ± 0.01	2.89 ^{eb} ± 0.02	2.25 ^B ± 0.06
T_1	1.77 ^{aA} ± 0.01	2.06 ^b ± 0.01	2.08 ^{bA} ± 0.01	2.08 ^{bA} ± 0.01	2.63 ^{cA} ± 0.02	2.13 ^A ± 0.05
Yeast and Mould Count (log₁₀cfu/g)						
T_0	N.D	N.D	1.87 ^{ab} ± 0.01	1.90 ^{bb} ± 0.01	2.11 ^{cb} ± 0.01	1.96 ^B ± 0.11
T_1	N.D	N.D	1.69 ^{aA} ± 0.05	1.87 ^{bA} ± 0.01	1.93 ^{cA} ± 0.03	1.83 ^A ± 0.02
Appearance**						
T_0	6.58 ± 0.10	6.54 ± 0.10	6.50 ± 0.10	6.41 ± 0.10	6.37 ± 0.10	6.48 ± 0.04
T_1	6.66 ± 0.10	6.62 ± 0.10	6.62 ± 0.10	6.54 ± 0.10	6.45 ± 0.10	6.58 ± 0.04
Flavor						
T_0	6.75 ± 0.09	6.79 ± 0.08	6.75 ± 0.09	6.66 ± 0.09	6.66 ± 0.09	6.72 ^A ± 0.04
T_1	6.91 ± 0.05	6.87 ± 0.06	6.87 ± 0.06	6.83 ± 0.07	6.75 ± 0.09	6.85 ^B ± 0.03
Juiciness						
T_0	6.79 ± 0.08	6.75 ± 0.09	6.70 ± 0.09	6.62 ± 0.10	6.54 ± 0.10	6.68 ^A ± 0.04
T_1	6.87 ± 0.06	6.83 ± 0.07	6.83 ± 0.05	6.75 ± 0.09	6.70 ± 0.09	6.80 ^B ± 0.03
Texture						
T_0	6.50 ± 0.10	6.45 ± 0.10	6.41 ± 0.10	6.33 ± 0.09	6.33 ± 0.09	6.40 ± 0.04
T_1	6.58 ± 0.10	6.54 ± 0.10	6.50 ± 0.10	6.45 ± 0.10	6.41 ± 0.10	6.50 ± 0.04
Mouth Coating						
T_0	7.00 ± 0.01	6.95 ± 0.20	6.91 ± 0.28	6.87 ± 0.33	6.87 ± 0.33	6.92 ± 0.26
T_1	7.00 ± 0.01	7.00 ± 0.01	6.95 ± 0.20	6.91 ± 0.28	6.87 ± 0.33	6.95 ± 0.21
Overall Palatability						
T_0	6.50 ± 0.10	6.50 ± 0.10	6.37 ± 0.10	6.33 ± 0.09	6.33 ± 0.09	6.40 ± 0.04
T_1	6.58 ± 0.10	6.54 ± 0.10	6.58 ± 0.10	6.50 ± 0.10	6.41 ± 0.10	6.52 ± 0.04

Nested Means (± SE) with same lower case superscripts row-wise and upper case superscripts column-wise for each attribute do not differ significantly ($P > 0.05$). Overall Means (± SE) with common lower case superscripts row-wise and upper case superscripts column-wise for each attribute do not differ significantly ($P > 0.05$). 8-Point Descriptive Scale (8=extremely desirable; 1=extremely undesirable). *n = 9/Storage interval/Treatment for pH, 6/Storage

interval/Treatment for other parameters. **n = 28/Storage interval/Treatment. T₀: Control; T₁: sodium alginate @ 0.1%.

Conflict Of Interest:-

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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