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Storage Stability of *Goshtaba* with α -Tocopherol as Anti-Oxidant

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A B S T R A C T

The effect of incorporation of α-Tocopherol at 0.02% on the quality and storage stability of *Goshtaba* was studied. The pH and emulsion stability of *Goshtaba* raw emulsion formulated with α-Tocopherol was significantly lower than control emulsion. In case of the cooked products, pH values, percent cooking yield and proximate composition except ash content of *Goshtaba* showed significant ($P<0.05$) difference. The overall palatability scores of *Goshtaba* samples showed comparable ($P>0.05$) results between the two groups. Another objective was to assess the effect of α-Tocopherol as anti-oxidant on the storage stability of *Goshtaba* after subjecting them to refrigerated storage for three weeks, at 4+1°C. The results have indicated that the pH and moisture of *Goshtaba* samples increased significantly during storage. 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. The total plate count and coliform count of *Goshtaba* samples increased significantly ($P<0.05$) during storage. In *Goshtaba* the Yeast and Mold counts were detected on day '7' with a significant increase ($P<0.05$) from day '7' today '21' of storage in both samples. The microbial counts in general remained low and well within permissible limits even at the end of the 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.

Introduction

Goshtaba is an emulsion based meat product prepared by pounding meat along with fat (20-30%) on a smooth surfaced stone. Fat plays a vital role in sensory properties by binding with heat induced gel, formed of salt extractable proteins in comminuted meat products (Jalal *et al.*, 2014). However, the addition of fat in such amounts makes this product more susceptible to oxidative changes resulting in the development of rancidity, off-lavors and thus an overall decrease in its sensory attributes and shelf-life. There is a need to find an effective solution to these issues and improve the quality of *Goshtaba* by inhibiting or decreasing the problem of lipid oxidation. Alpha-tocopherol is a natural antioxidant used in meat and meat products to retard or inhibit lipid oxidation (Sahoo and Anjaneyulu, 2000; Verma and Sahoo, 2000; Abou-Arab and Abu-Salem, 2010). Hence,

keeping in view the importance of *Goshtaba* and associated risk of lipid oxidation, the present study was undertaken with the objective of studying the effect of α-Tocopherol on the quality and storage stability of *Goshtaba.*

Materials and Methods

Lean mutton and fat obtained from young and tender male lambs in the age group of 6-9 months, 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 and vegetable oil were purchased from local market. α-Tocopherol (DL-α-Tocopherol acetate; HiMedia Laboratories Private Limited, Mumbai) was used in product preparation. The product was prepared following the standardized procedure and of Samoon (1988) with slight modifications. The basic formulation (Table 1), without any modification, served as control (T_0) and batter supplemented with α-Tocopherol @ 0.02 % served as treatment–1 (T_1).

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 (Jalal *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 α-Tocopherol the emulsion was further subjected to pounding to ensure uniform mixing of the anti-oxidant. It was then moulded in the shape of spherical balls and kept in refrigerator. 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.

Moisture, protein, fat and ash content of raw emulsion, cooked product and gravy was estimated as per the method of Association of Official Analytical Chemists (AOAC 1995). The pH was determined by following the method of Keller *et al.,* (1974). The emulsion stability of the raw samples was determined as per the method of Baliga and Madaiah (1970). The cooking yield percent was calculated by dividing the weight of cooked balls with weight of uncooked balls. The product along with its gravy was aerobically packaged in LDPE bags and stored at 4±1^{o}C for a period of three weeks during which the product sample was drawn at weekly intervals and evaluated for physico-chemical parameters, microbiological quality and sensory characteristics. Standard methods were used to estimate pH of the cooked samples (Keller *et al.,* 1974), thiobarbituric

acid (TBA) value (Witte *et al.,* 1970) with slight modifications, total plate count (Maturin and Peeler 2001), coliform count (Feng *et al.,* 2002) and yeast and mould count (Tournas *et al.,* 2001). Sensory quality was evaluated as per Seman *et al.,* (1987) wherein the product chunks in their respective gravies at a temperature of 30-35^{0}C were assessed under incandescent light for their appearance, flavour, juiciness, texture and overall palatability by a group of not less than 8 experienced panel of judges. Water was provided between samples to cleanse the palate. The data obtained from three replications were analysed by ANOVA. Duncan's Multiple Range test and critical difference were determined at 5% significance level using SPSS-version 17.0.

Results and Discussion

The physico-chemical and microbiological quality of the cooked product (low fat *Goshtaba* balls) are depicted in tables 2 and 3, respectively.

Cooked Goshtaba balls exhibited a lower pH than the emulsion which might be due to the added effect of curd used in the formulation. Similarly, the gravy of *Goshtaba* (*Yakhni*) formulated with α-Tocopherol also exhibited a lower pH than the *Yakhni* of control but the difference was non-significant (P>0.05). Similar finding was reported by Verma and Sahoo (2000) and Sahoo and Anjaneyulu (1997a). The emulsion stability of α-Tocopherol formulated raw emulsion for *Goshtaba* was significantly better (P<0.05) than that of control raw emulsion. Vitamin E is regarded to have a surfactant-like structure, which consists of both hydrophilic and hydrophobic groups due to which vitamin E will be adsorbed at the oil/water interface and could help to lower the surface tension and thus increase the emulsion stability (Teo *et al.,* 2010). The cooking yield of α-Tocopherol formulated *Goshtaba* samples was significantly higher (P<0.05) than the control samples. The increased cooking yields of α-Tocopherol formulated samples could be attributed to their efficiency to form stable emulsion thus lowering the cooking losses and consequently increasing the cooking yields as was also reported by Verma and Sahoo (2000) in ground chevon. α-Tocopherol formulated *Goshtaba* balls had a significantly lower (P<0.05) moisture content than that of the control samples. Better fat retention in α-Tocopherol formulated samples might have caused a reduction in the moisture content on percentage basis as observed by Jalal *et al.,* (2014) and Hussain *et al.,* (2015) in their study.

The protein/fat content of the α-Tocopherol formulated product was significantly (P<0.05) higher than control samples. But, a reverse trend was observed in case of gravy where the protein/fat content of α-Tocopherol formulated *Goshtaba* was significantly lower (P<0.05) than that of the gravy of control. The higher emulsion stability of α-Tocopherol formulated *Goshtaba* samples might have caused higher retention of protein/fat in the product at the time of cooking and thus a relatively lower loss in the respective gravy.

These findings were in agreement with Hussain *et al.,* (2015) who also reported increased protein/fat content in those *Rista* samples which exhibited higher emulsion stability values and thus lower losses in the respective gravies. No significant differences (P>0.05) were observed between the two treatments with respect to the ash content of the emulsions for *Goshtaba,* the cooked product and the gravy. This was expected as the formulations were exactly the same for various treatments under each product except for the addition of antioxidants which would not affect the ash content. Similar results were obtained by Hussain *et al.,* (2015).

Appearance, Juiciness and texture scores of the α-Tocopherol formulated *Goshtaba* samples were significantly higher (P<0.05) than those of the control samples. On an 8-point descriptive scale, these scores for control samples ranged above 6 but never reached 7 and were thus rated as good, whereas the scores of α-Tocopherol formulated samples generally ranged 7 and above and were thus rated as very good. Better appearance of the α-Tocopherol formulated samples might be attributed to more desirable colour, better fat dispersion and better binding leading to a more uniform cross–sectional appearance as compared to the control samples. Similarly, better emulsion stability of the batter offered by the addition of α-Tocopherol might have been responsible for the better texture of α-Tocopherol formulated *Goshtaba* samples as compared to the control. Better colour and appearance, and texture scores were also reported by Hussain *et al.,* (2015) in *Rista* treated with α-tocopherol. Higher juiciness scores of α-Tocopherol formulated samples than that of the control samples as observed in the present study could not be explained adequately. However, Hussain *et al.,* (2015) attributed improved product juiciness observed in his study to higher fat. There was no significant difference (P>0.05) among the flavour scores of different treatments in *Goshtaba* samples. Sahoo and Anjaneyulu (1997b) reported higher flavour scores in buffalo meat nuggets treated with α-tocopherol acetate, sodium ascorbate and sodium tripolyphosphate.

No significant differences (P>0.05) were observed in the mouth coating and overall palatability scores of *Goshtaba* under various treatments, the values being comparable. With respect to the overall palatability scores, a trend similar to that observed for other sensory attributes was evident in *Goshtaba* samples, the scores being significantly higher (P<0.05) for α-Tocopherol formulated samples as compared to control.

With the advancement of storage period, the pH values of both the groups increased significantly. Hussain *et al.,* (2015) reported a linear increase in pH of α-Tocopherol treated *Rista* during refrigerated storage and also observed that α-Tocopherol treated samples exhibited a significantly lower pH than control samples as was the case in the present study. The percent moisture content of the control and α-Tocopherol formulated *Goshtaba* samples increased with storage and became significant as the storage progressed. This might be due to linear increase in pH of the samples. Similar results were observed by Sahoo and Anjaneyulu (2000) in their study on the quality of pre-blended ground buffalo meat treated with α-Tocopherol. During storage an increase in the mean TBA values was observed between two groups, the difference in values was significant (P<0.05) at successive storage intervals.

Table.1 Basic formulation for *Goshtaba*

S. No.	Name of the ingredient	Percentage
01.	Mutton (boneless)	80.00
02.	Mutton fat	20.00
Total		**100.00**
To the above, following ingredients were added (on weight basis)		
03.	Common salt	2.50
04.	Chilled water/Ice flaks	10.00
05.	Large cardamom seeds	0.20

Table.2 Effect of α-Tocopherol on the physico-chemical and sensory quality of *Goshtaba* (Mean ± SE)

Physico-chemical attributes*	Raw Emulsion		Cooked Product		*Goshtaba* Gravy		Sensory attributes**	T_0	T_1
	T_0	T_1	T_0	T_1	T_0	T_1			
pH	5.97^{b}±0.01	5.89^{a}±0.004	5.67^{b}±0.02	5.58^{a}±0.01	4.89±0.004	4.83±0.19	**Appearance**	6.60^{a}±0.18	7.12^{b}±0.13
Moisture	63.94±0.15	63.70±0.20	62.67^{b}±0.21	61.87^{a}±0.18	78.50±0.46	78.58±0.15	**Flavour**	6.64±0.18	6.72±0.16
Protein	16.13±0.07	16.24±0.09	14.28^{a}±0.17	14.84^{b}±0.09	2.76^{b}±0.11	2.28^{a}±0.07	**Juiciness**	6.56^{a}±0.14	7.08^{b}±0.10
Fat	16.74±0.12	16.96±0.16	17.55^{a}±0.26	18.52^{b}±0.17	11.92^{b}±0.31	11.09^{a}±0.05	**Texture**	6.24^{a}±0.20	6.96^{b}±0.09
Ash	2.08±0.07	2.12±0.04	2.49±0.06	2.63±0.03	2.62±0.06	2.49±0.05	**Mouth Coating**	6.88±0.22	7.08±0.19
Emulsion stability	7.55^{b}±0.03	7.12^{a}±0.02	-	-	-	-	**Overall Palatability**	6.56^{a}±0.18	7.12^{b}±0.09
Cooking Yield	-	-	92.25^{a}±0.48	94.96^{b}±0.32	-	-	-	-	-

Means with different superscripts row-wise differ significantly (P<0.05),*n = 9/ treatment for pH and moisture, 6/Treatment for other parameters.T_0 (Control); T_1 (α-Tocopherol @ 0.02%), 8-point Descriptive Scale (8=extremely desirable, 1=extremely undesirable), ** n = 30/Treatment.

Table.3 Effect of refrigerated storage and α-Tocopherol on physico-chemical, microbiological and Sensory characteristics of *Goshtaba*

Treatments**	Storage period (days)				Overall
	0	7	14	21	
pH					
T_0	5.36^{aB}±0.02	5.55^{bC}±0.01	6.12^{cC}±0.02	6.39^{dC}±0.01	5.86^{C}±0.09
T_1	5.26^{aA}±0.01	5.39^{bA}±0.01	5.73^{cB}±0.02	6.19^{dB}±0.01	5.64^{B}±0.07
Moisture (%)					
T_0	62.89^{aB}±0.09	63.52^{aA}±0.03	67.51^{bB}±0.94	70.80^{cB}±0.70	66.18^{B}±0.72
T_1	60.82^{aA}±0.31	62.64^{bA}±0.53	66.22^{cAB}±0.53	69.04^{dB}±0.86	64.68^{A}±0.72
TBA (mg malonaldehyde/Kg)					
T_0	0.15^{aA}±0.001	0.36^{bC}±0.02	0.53^{cC}±0.01	0.68^{dC}±0.01	0.43^{C}±0.04
T_1	0.15^{aA}±0.001	0.19^{bA}±0.002	0.24^{cA}±0.01	0.34^{dA}±0.01	0.23^{A}±0.01

Total Plate Count (log10cfu/g)					
T_0	$1.93^{a}\pm0.06$	$2.49^{bB}\pm0.04$	$3.59^{cB}\pm0.06$	$4.32^{dB}\pm0.09$	$3.08^{B}\pm0.20$
T_1	$1.91^{a}\pm0.06$	$2.56^{bB}\pm0.04$	$3.48^{cB}\pm0.13$	$4.21^{dB}\pm0.04$	$3.04^{B}\pm0.19$
Coliform Count (log10cfu/g)					
T_0	$1.21^{a}\pm0.25$	$1.51^{a}\pm0.11$	$2.30^{bB}\pm0.05$	$2.57^{bB}\pm0.03$	$1.90^{B}\pm0.13$
T_1	$1.19^{a}\pm0.40$	$1.48^{b}\pm0.08$	$2.26^{bB}\pm0.05$	$2.56^{bB}\pm0.05$	$1.87^{B}\pm0.15$
Yeast and Mould Count (log10cfu/g)					
T_0	N.D	1.94 ± 0.06^{aB}	$2.18^{bB}\pm0.03$	$2.29^{cB}\pm0.02$	$1.60^{B}\pm0.20$
T_1	N.D	1.89 ± 0.03^{aB}	$2.13^{bB}\pm0.04$	$2.23^{cB}\pm0.03$	$1.56^{B}\pm0.19$
Appearance					
T_0	$7.34^{b}\pm0.10$	$7.00^{a}\pm0.11$	$6.97^{aA}\pm0.03$	$6.79^{aA}\pm0.09$	$7.03^{A}\pm0.05$
T_1	$7.45^{b}\pm0.09$	$7.28^{ab}\pm0.08$	$7.21^{aB}\pm0.08$	$7.14^{aB}\pm0.07$	$7.27^{B}\pm0.04$
Flavour					
T_0	$7.38^{b}\pm0.13$	$7.10^{b}\pm0.11$	$6.38^{aA}\pm0.12$	$6.17^{aA}\pm0.10$	$6.76^{A}\pm0.07$
T_1	$7.45^{b}\pm0.09$	$7.31^{b}\pm0.09$	$6.93^{aB}\pm0.05$	$6.83^{aB}\pm0.12$	$7.13^{B}\pm0.05$
Juicines					
T_0	$7.28^{bA}\pm0.11$	$7.10^{bA}\pm0.11$	$6.52^{aA}\pm0.11$	$6.45^{aA}\pm0.18$	$6.84^{A}\pm0.07$
T_1	$7.62^{bB}\pm0.09$	$7.45^{bB}\pm0.12$	$6.76^{aAB}\pm0.11$	$6.52^{aA}\pm0.13$	$7.09^{B}\pm0.07$
Texture					
T_0	$7.34^{bA}\pm0.14$	$7.10^{bA}\pm0.06$	$6.62^{aA}\pm0.14$	$6.48^{aA}\pm0.09$	$6.89^{A}\pm0.06$
T_1	$7.72^{cB}\pm0.08$	$7.45^{bB}\pm0.11$	$7.00^{aB}\pm0.00$	$6.83^{aB}\pm0.10$	$7.25^{C}\pm0.05$
Mouth Coating					
T_0	$7.59^{c}\pm0.11$	$7.21^{b}\pm0.13$	$7.17^{b}\pm0.13$	$6.83^{a}\pm0.11$	7.20 ± 0.07
T_1	$7.62^{c}\pm0.10$	$7.28^{b}\pm0.08$	$7.21^{b}\pm0.09$	$6.97^{a}\pm0.03$	7.27 ± 0.05
Overall Palatability					
T_0	$7.34^{b}\pm0.13$	$7.00^{bA}\pm0.12$	$6.38^{aA}\pm0.12$	$6.24^{aA}\pm0.15$	$6.74^{A}\pm0.08$
T_1	$7.52^{b}\pm0.11$	$7.34^{bB}\pm0.09$	$6.83^{aB}\pm0.09$	$6.76^{aB}\pm0.18$	$7.11^{B}\pm0.07$

Nested Means (± SE) with same lower case superscripts row-wise and upper case superscripts column-wise for each parameter do not differ significantly (P>0.05). Overall Means (± SE) with common upper case superscripts column-wise for each parameter do not differ significantly (P>0.05). *n = 6/Storage interval/Treatment. **T_0 (Control); T_1 (α-Tocopherol @ 0.02%). 1: 8-point Descriptive Scale (8=extremely desirable, 1=extremely undesirable). [1]*n = 28/Storage interval/Treatment. ** T_0 (Control); T_1 (α-Tocopherol @ 0.02%).

The increase in TBA values might be due to progressive increase in lipid oxidation of the products. Abou-Arab and Abu-salem (2010) also reported similar findings for Rosemary and α-Tocopherol treated ostrich steaks during refrigerated storage for 21 days. Love and Pearson (1974) reported that the TBA value of 1.0 and above were generally associated with rancidity problems. Thus, the TBA values in the present study have never exceeded the values expected to produce off odours and off-flavours. The total plate counts of both the treatments of *Goshtaba* samples increased significantly. Notwithstanding the significant difference between the treatment counts at various storage intervals, the increase in total plate counts was modest and far below the incipient spoilage level of log7/g (Hytiainen *et al.,* 1975; Frazier and Westhoff, 1988). The mean coliform counts for both the groups of *Goshtaba* samples observed in the present study were well within maximum suggestive limits of 2.69 logcfu/g indicated by Goldenberg and Elliot (1973). The yeast and mould counts of α-Tocopherol formulated samples was non-significantly lower (P>0.05) than that of the control samples. The yeast and mould counts were detected on day '14' of the storage. Hussain *et al.,* (2015) detected Yeast and Mould counts on day '7' of storage of α-tocopherol treated Rista balls. This might be due to more acidic nature of *Goshtaba Yakhni* (containing curd) which may have favoured the growth of fungi (Yeasts and Moulds) as these are more acid tolerant (Frazier and Westhoff, 1988).

The overall mean appearance, flavour, juiciness and texture scores for the α-Tocopherol formulated samples were higher than that of the control samples. During refrigerated storage a gradual decrease in the flavour scores might be due to progressive increase in the lipid oxidation as depicted by increase in the TBA as well as by increase in the microbial load of the products. Similarly, during the initial period of storage intervals the higher juiciness scores of α-Tocopherol formulated samples might be due to higher fat retention owing to better emulsion stability. However, as storage progressed, the relatively faster microbial growth in control and α-Tocopherol formulated samples might have lead to increased fat losses with subsequent decrease in their juiciness scores. During the storage period a gradual decrease in the texture scores might be attributed to the breakdown of fat and protein. Similar trend of decreasing scores with the progress of storage was reported by, Hussain *et al.,* (2015) in α-Tocopherol treated *Rista* balls and Verma and Sahoo (2000) in ground chevon treated with α-Tocopherol. The mouth coating scores seem to be least affected by storage period as the score remained 7+ (practically none) upto day '14'. The overall palatability scores of the α-Tocopherol formulated *Goshtaba* samples was significantly (P<0.05) higher than that of control samples. Our findings were in agreement with Hussain *et al.,* (2015). From the study, it was concluded that the incorporation of α-Tocopherol at 0.02% level, in *Goshtaba* could be one of the alternatives to address the problem of lipid oxidation with beneficial effects on quality and storage stability.

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