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Storage behaviour of *Rista* (meatballs cooked in spiced curry) under aerobic refrigerated storage conditions

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ABSTRACT

The present study was conducted to study the effect of aerobic packaging system on the storage stability of Rista (meatballs cooked in spiced curry) under refrigeration temperature**.** A total of three types of Rista developed including: T_0 as control Rista (lean meat: animal fat = 90:10 in the formulation), T_1 as fiber rich Rista (lean meat: animal fat: hydrated wheat bran=82:10:8 in the formulation) T_2 as antioxidant rich Rista (lean meat: animal fat=90:10 in the formulation and fortified with 0.1% grape seed extract) and were packaged aerobically in LDPE pouches and stored at refrigeration temperature (4±1°C). The samples were analysed during storage (on days 0, 7, 10, 13, 16, 19). The results revealed that the emulsion stability (%), cooking yield (%), pH and water activity presenting the mean of 93.67, 95.61, 94.47; 91.59, 95.49, 93.38; 6.29, 6.65, 6.54 and 0.98, 0.99, 0.99 in T_0, T_1 and T_2, respectively. The sensory values for various sensory parameters viz appearance, flavour, texture, saltiness and overall acceptability followed a decreasing trend with the storage. The microbial parameters like total plate count increased significantly throughout the storage period; total psychrotrophic count was detected from 13th day of storage and coliform count was not detected throughout the storage period. The observations concluded that the product can be stored in aerobically packaged LDPE pouches for 16 days without much change in physicochemical, microbiological and sensory properties at refrigerated storage.

Key words: Antioxidant Fiber, Meatballs, Refrigeration, Rista

INTRODUCTION

The marketability of all *Wazwan* (famous meat based Kashmiri cuisine of 7-36 dishes) dishes including Rista (meatballs cooked in spiced curry) is mainly restricted to local populace because of the lack of scientific interventions necessary to upscale the product as there is a total ignorance among the traditional *Wazwan* handlers about the scientific and hygienic processing of the product (Qureshi *et al*., 2021). High fat content is used in the formulation of Rista which consequently reduces shelf life and acceptance by health-conscious consumers. These negative effects associated with animal fats can be partially taken care of by replacing them with vegetable oils

(Bumla *et al.*, 2021), besides increasing the fiber and antioxidant content; thereby expecting a better shelf life of the product. Proper packaging will ensure extended shelf-life of these products, thereby making their transport to distant areas possible. Keeping these things in consideration, functional Rista were developed by increasing their dietary fiber and antioxidant content (Qureshi *et al.*, 2021; Bumla *et al.*, 2021). The refrigerated shelf life of these products will give a clear idea about their storage behaviour, which maybe be used as needful information to ascertain the marketability potential beyond traditional boundaries.

MATERIALS AND METHODS

Hind leg portions from the freshly dressed sheep carcasses (12-18 months old animals) were procured from the local market. Deboning was done immediately and the lean meat obtained (after its rigor stage) was used for the preparation of the product (immediately or later as per need). Animal fat used in the experiments was obtained from the carcass of the same kill. Low density polyethylene (LDPE) films (thickness of 0.015 mm) were used for the aerobic packaging of Rista. Wheat bran was procured from the local market. Wheat bran was hydrated with chilled water (1:1 hydration) and was be kept as such for 30 min at refrigeration temperature before use. Grape seed extract capsules (*Vitis vinifera*) manufactured by HealthyHey Foods, Mahrashtra were used as antioxidant source.

Preparation of Rista

The machine processing as standardized after the earlier experiments at the Division of Livestock Products Technology, FVSc and AH was adopted for processing of emulsion for Rista (Qureshi *et al.*, 2021). The raw emulsion obtained was moulded in the shape of spherical balls (50-70g) and then kept in refrigeration until cooked in boiling gravy. The levels of hydrated wheat bran (8%) as dietary fiber source and grape seed extract (0.1%) as antioxidant source were standardized by earlier workers (Qureshi, 2022; Haq, 2022). A total of three types of Rista were developed for storage study (table 1).

i. T0 (lean meat: animal fat = 90:10 in the formulation)
ii. T1 (lean meat: animal fat: hydrated wheat bran=82:10:8 in the formulation)
iii. T2 (lean meat: animal fat=90:10 in the formulation) and fortified with 0.1% grape seed extract as an antioxidant source.

All the treatments (T_0, T_1 and T_2) were packaged aerobically in LDPE and stored at refrigeration temperature (4±1°C). The samples were analysed during storage till the product was not fit for consumption based on sensory and microbiological parameters.

Table 1. Formulation of Rista

Ingredients	Percentage (% on weight basis)		
	T_0 (Control)	T_1 (Fiber Rich)	T_2 (Antioxidant Rich)
Lean meat	90	82	90
Animal fat	10	10	10
Wheat bran (1:1 hydrated)	-	8	-
Total	100	100	100
Grape seed extract	-	-	0.1
To the above, following ingredients shall be added (on weight basis)			
Sodium chloride	2.0	2.0	2.0
Potassium chloride	0.5	0.5	0.5
Chilled water/Ice flakes	10.0	10.0	10.0
Large cardamom seeds	0.20	0.20	0.20

(Hussain, 2011)

Analytical procedures

The emulsion stability of the raw samples was determined as per the method of Baliga and Madaiah (1970) with slight modifications. For cooking yield, the weight of Rista was recorded before and after cooking and then the values were expressed in percentage. The pH was determined by the method of Trout *et* al. (1992) by using digital pH meter (Model EE-011, Tanco Laboratory Equipments Ltd. India). The per cent moisture, protein, fat and ash content of the product samples were evaluated as per standard procedure of Association of Official Analytical Chemists (AOAC, 2019). For sensory evaluation, samples of products from all treatments were presented to the semi-trained experienced taste panel members consisting of scientists and post-graduate students (both male and female) of Faculty of Veterinary Sciences and Animal Husbandry, Shuhama, SKUAST-K for evaluation of various sensory parameters as per 8-point descriptive scale (Keeton, 1983), where 8 is extremely desirable and 1 is extremely undesirable. The microbiological quality was assessed by following the methods as described by APHA (2015). The data generated (6 observations per parameter and 21 observations for sensory parameters) was analyzed statistically following the method of Snedecor and Cochran (1994) using SPSS version 20 software package. Analysis of variance was

computed with 5% level of significance. Duncan's MRT was used for determination of statistical significance.

RESULTS AND DISCUSSION

The values obtained for emulsion stability and cooking yield are given in table-2. The values for T_0 for emulsion stability and cooking yield were significantly lower than T_1 and T_2. The results were in agreement with Haq, (2022) whose results revealed that the emulsion stability and cooking yield of wheat bran incorporated Rista were significantly ($p<0.05$) higher than the control. The increase in emulsion stability and cooking yield might be attributed to increased holding and entrapping of moisture by wheat bran during the application of heat. The results were in agreement with Cofrades *et al*. (2000), who stated that the increase in cooking yield with the addition of dietary fibre might be due to their water and fat binding properties. Qureshi, (2022) reported a non-significant ($P>0.05$) increase in the cooking yield value with increasing levels of grape seed extract in Rista.

Table-2: Physicochemical properties (emulsion stability and cooking yield) of Rista

Treatment	Emulsion stability	Cooking Yield
T_0	93.67±0.13^{a}	91.59±0.16^{a}
T_1	95.61±0.08^{c}	95.49±0.10^{c}
T_2	94.47±0.09^{b}	93.38±0.06^{b}
Day Mean	94.58±0.20	93.49±0.39

Overall mean pH values for a period of 19 days of T_0, T_1 and T_2 were found to be 6.29±0.02, 6.65 ±0.01 and 6.54±0.01 respectively (Table-3). During storage, an overall increase in pH was observed in T_0 and T_1, while in case of T_2, pH decreased. The pH increased significantly during the whole storage period (T_0 and T_1). The mean pH of all the three treatments differed significantly from each other. The increase in the pH in the first two treatments can be due to the accumulation of metabolites by bacterial action in meat in addition to protein and amino acid degradation resulting in the formation of ammonia and consequent increase in pH. In case of third treatment, in which GSE was incorporated, pH values decreased significantly. This could be due to breakdown of carbohydrates into organic acids and also because of grape seed extract addition. Mir and Masoodi (2017) found that the pH of the value-added mutton meatballs increased non-significantly ($P>0.05$) during refrigerated storage for 10 days for both control and mutton meatballs groups under both vacuum and aerobic packaging. Also, results were in agreement with Ozuvural and Vural (2011), who found that there was a significant decrease in the pH during storage in frankfurters incorporated with GSE. Overall mean aW values of T_0, T_1 and T_2 were 0.98 ± 0.00, 0.99±0.00 and 0.99±0.00 respectively (Table-3). The increase in water activity might be due to the equilibration of water activity between meat pieces and the slurry of cookout, spices solutes. The results were in agreement with Malik and Sharma (2014), who reported increased water activity in ready-to-eat spiced buffalo meat products during first week and later remained stable with no significant change up to the end of 7 weeks storage period. Also, our results were in correspondence with Kumar *et al*. (2016) who reported an increase in water activity of chicken meat biscuits incorporated with wheat and oat bran.

The values obtained for the sensory quality on the storage stability of Rista are reported in table 4. The sensory quality parameters (general appearance, tex-

Table 3: Physicochemical properties (pH and aW) of Rista during aerobic storage

Treatment	Storage periods (days)						Treatment Mean
	0	7	10	13	16	19	
Ph							
T_0	6.10±0.06^{aA}	6.17±0.05^{aAB}	6.27±0.04^{aBC}	6.35±0.04^{aCD}	6.40±0.03^{aCD}	6.46±0.03^{aD}	6.29±0.02^{a}
T_1	6.57±0.04^{bA}	6.60±0.09^{bAB}	6.64±0.04^{bAB}	6.67±0.03^{aAB}	6.70±0.04^{bB}	6.73±0.03^{aB}	6.65±0.01^{c}
T_2	6.63±0.02^{bD}	6.59±0.02^{bCD}	6.54±0.01^{bBC}	6.50±0.01^{bAB}	6.49±0.01^{cAB}	6.48±0.01^{bA}	6.54±0.01^{b}
Day Mean	6.43±0.06^{A}	6.45±0.05^{A}	6.48±0.04^{A}	6.51±0.03^{A}	6.53±0.03^{A}	6.55±0.03^{A}	
Wa							
T_0	0.96±0.00^{aA}	0.97±0.00^{aAB}	0.98±0.01^{aB}	0.99±0.00^{aC}	0.99±0.00^{aC}	1.00±0.00^{C}	0.98±0.00^{a}
T_1	0.97±0.00^{bA}	0.98±0.00^{bB}	0.98±0.00^{bB}	0.99±0.00^{bC}	0.99±0.00^{aC}	1.00±0.00^{C}	0.99±0.00^{b}
T_2	0.98±0.00^{bA}	0.98±0.00^{bB}	0.99±0.00^{bC}	1.00±0.00^{bD}	1.00±0.00^{aD}	1.00±0.00^{D}	0.99±0.00^{b}
Day Mean	0.97±0.00^{A}	0.98±0.00^{B}	0.98±0.00^{C}	0.99±0.00^{D}	0.99±0.00^{D}	1.00±0.00^{D}	

Mean ± SE with different small letters column-wise and capital letters row-wise as superscripts differ significantly ($P<0.05$), N =6

ture, juiciness, saltiness, mouth coating and overall acceptability) decreased significantly along the storage period. The decrease in appearance scores could be due to surface dehydration in aerobic packaging and some pigment and lipid oxidation resulting in metmyoglobin accumulation and non-enzymatic browning. A gradual decrease in flavour might be due to expected loss of volatile flavour components from spices and condiments on storage of meat products. A decrease in texture scores might be due to protein oxidation and microbial action on proteins leading to proteolytic and disulphide bond changes with the progress of the storage period. The results were in correspondence with Qureshi (2022), who reported a decrease in the sensory parameters along the storage period. Sensory quality of all the products was found to be acceptable up to the 16th day, thereafter the products were found unacceptable by the sensory panellists.

Table 4. Effect of storage period on the sensory attributes of aerobically packaged Rista under refrigeration (Mean±S.E)

Treatments	Storage periods (days)						Treatments Mean ± SE
	0	7	10	13	16	19	
Appearance							
T_0	7.00±0.00^{E}	6.47±0.11^{aD}	5.47±0.11^{aC}	5.38±0.10^{bC}	5.00±0.00^{bB}	4.23±0.09^{bA}	5.59±0.08^{a}
T_1	7.00±0.00^{E}	6.61±0.10^{aD}	5.57±0.11^{aC}	4.85±0.07^{aB}	4.87±0.07^{bB}	4.00±0.00^{aA}	5.48±0.09^{a}
T_2	7.00±0.00^{E}	6.33±0.10^{aD}	5.47±0.11^{aC}	5.28±0.14^{bC}	4.42±0.11^{aB}	3.80±0.08^{aA}	5.38±0.10^{a}
Day mean ± SE	7.00±0.00^{F}	6.47±0.06^{E}	5.50±0.06^{D}	5.17±0.06^{C}	4.76±0.05^{B}	4.01±0.04^{A}	
Flavour							
T_0	7.14±0.07^{bE}	6.95±0.04^{cE}	6.47±0.11^{cD}	6.00±0.00^{aC}	5.00±0.00^{bB}	4.47±0.11^{bA}	6.00±0.09^{c}
T_1	7.00±0.00^{bE}	6.00±0.00^{aD}	6.00±0.00^{bD}	5.71±0.10^{bC}	5.00±0.00^{bB}	4.47±0.11^{bA}	5.69±0.07^{b}
T_2	6.71±0.10^{aE}	6.28±0.10^{bD}	5.52±0.11^{aC}	5.00±0.00^{cB}	4.80±0.08^{aB}	3.71±0.10^{aA}	5.34±0.09^{a}
Day mean ± SE	6.95±0.04^{F}	6.41±0.62^{E}	6.00±0.71^{D}	5.57±0.06^{C}	4.93±0.30^{B}	4.22±0.07^{A}	
Texture							
T_0	7.85±0.07^{cE}	7.28±0.10^{cD}	6.66±0.10^{bC}	6.66±0.10^{cC}	5.80±0.08^{aB}	5.00±0.00^{bA}	6.54±0.09^{c}
T_1	7.00±0.00^{aD}	7.00±0.00^{bD}	7.00±0.00^{cD}	6.00±0.00^{bC}	5.76±0.09^{aB}	4.61±0.10^{aA}	6.23±0.08^{b}
T_2	7.28±0.10^{bE}	6.76±0.09^{aD}	6.28±0.10^{aC}	5.61±0.10^{aB}	5.71±0.10^{aB}	4.52±0.11^{aA}	4.52±0.11^{a}
Day mean ± SE	7.38±0.06^{F}	7.01±0.05^{E}	6.65±0.06^{D}	6.09±0.07^{C}	5.76±0.05^{B}	4.71±0.05^{A}	6.26±0.05
Juiciness							
T_0	7.76±0.09^{bF}	7.00±0.00^{bE}	6.47±0.11^{bD}	6.00±0.00^{aC}	5.00±0.00^{bB}	4.57±0.11^{cA}	6.13±0.10^{b}
T_1	7.52±0.11^{bF}	6.61±0.10^{bE}	6.09±0.06^{aD}	5.33±0.10^{bC}	4.28±0.10^{bB}	3.80±0.08^{bA}	5.61±0.12^{a}
T_2	7.19±0.08^{aE}	7.00±0.11^{aE}	6.14±0.00^{aD}	4.33±0.10^{aC}	3.90±0.06^{aB}	3.00±0.00^{aA}	5.26±0.14^{a}
Day mean ± SE	7.49±0.06^{F}	6.87±0.04^{E}	6.23±0.03^{D}	5.22±0.096^{C}	4.39±0.06^{B}	3.79±0.09^{A}	
Mouth Coating							
T_0	7.80±0.08^{cF}	7.33±0.10^{bE}	7.00±0.00^{bD}	6.57±0.11^{aC}	6.00±0.00^{bB}	5.42±0.11^{cA}	6.58±0.09^{b}
T_1	7.00±0.00^{aD}	7.00±0.00^{aD}	7.00±0.00^{bD}	6.66±0.10^{bC}	6.00±0.00^{bB}	5.00±0.00^{bA}	6.34±0.08^{a}
T_2	7.28±0.10^{bF}	6.85±0.07^{aE}	6.57±0.11^{aD}	6.28±0.10^{aC}	5.71±0.10^{aB}	4.14±0.07^{aA}	6.20±0.08^{a}
Day mean ± SE	7.36±0.06^{F}	7.06±0.04^{E}	6.85±0.04^{D}	6.50±0.06^{C}	5.90±0.03^{B}	4.85±0.08^{A}	
Saltiness							
T_0	7.00±0.00^{bD}	6.52±0.10^{bC}	5.76±0.09^{bB}	4.66±0.10^{aA}	4.66±0.10^{aA}	4.66±0.10^{bA}	5.54±0.09^{b}
T_1	7.00±0.00^{bC}	5.76±0.10^{aB}	4.61±0.10^{aA}	4.61±0.10^{aA}	4.66±0.10^{aA}	4.66±0.10^{bA}	5.22±0.08^{a}
T_2	6.38±0.10^{aD}	5.90±0.11^{aC}	4.71±0.08^{aB}	4.71±0.10^{aB}	4.71±0.10^{aB}	4.00±0.00^{aA}	5.07±0.08^{a}
Day mean ± SE	6.79±0.05^{E}	6.06±0.06^{D}	5.03±0.08^{C}	4.66±0.05^{B}	4.68±0.59^{B}	4.44±0.06^{A}	
Overall Acceptability							
T_0	7.00±0.00^{aE}	7.00±0.00^{bE}	6.71±0.10^{aD}	5.61±0.10^{cC}	4.90±0.06^{abB}	4.66±0.10^{bA}	5.97±0.09^{a}
T_1	7.33±0.10^{bE}	6.76±0.09^{aD}	6.42±0.11^{aC}	5.28±0.10^{bB}	4.80±0.08^{aA}	4.66±0.10^{bA}	5.88±0.09^{a}
T_2	7.38±0.10^{bE}	7.00±0.00^{bD}	6.66±0.18^{aC}	5.00±0.00^{aB}	5.00±0.00^{bB}	4.00±0.00^{aA}	5.84±0.11^{a}
Day mean ± SE	7.23±0.05^{F}	6.92±0.03^{E}	6.60±0.06^{D}	5.30±0.05^{C}	4.90±0.03^{B}	4.44±0.06^{A}	

Mean ± SE with different small letters column-wise and capital letters row-wise as superscripts differ significantly (P≤0.05)
N =21, 8-point descriptive scale (8 = extremely desirable, 1 = extremely undesirable)

Table 5. Effect of storage period on the microbiology of aerobically packaged Rista under refrigeration (Mean±S.E)

Treatments	Storage periods (days)						Treatments Mean ± SE
	0	7	10	13	16	19	
Total Plate Count (log cfu/g)							
T_0	2.15±0.00^{cA}	2.60±0.07^{cB}	3.12±0.07^{cC}	3.78±0.04^{bD}	4.23±0.03^{bE}	4.69±0.04^{bF}	3.43±0.15^{b}
T_1	2.00±0.02^{bA}	2.19±0.03^{bB}	2.69±0.04^{bC}	3.00±0.05^{aD}	3.27±0.05^{aE}	3.75±0.05^{aF}	2.82±0.10^{a}
T_2	1.78±0.03^{aA}	2.03±0.02^{aB}	2.47±0.03^{aC}	2.91±0.03^{aD}	3.31±0.06^{aE}	3.81±0.07^{aF}	2.72±0.12^{a}
Day mean ± SE	1.98±0.04^{A}	2.27±0.06^{B}	2.76±0.07^{C}	3.23±0.09^{D}	3.60±0.11^{E}	4.08±0.10^{F}	
Psychrophillic Count (log cfu/g)							
T_0				2.42±0.03^{cB}	2.64±0.06^{cC}	2.80±0.09^{bD}	1.31±0.22^{a}
T_1		Not Detected		1.65±0.08^{bB}	1.90±0.10^{bAB}	2.16±0.17^{aC}	0.95±0.16^{a}
T_2				1.42±0.05^{aB}	1.68±0.03^{aC}	1.85±0.02^{aD}	0.82±0.14^{a}
Day mean ± SE				1.83±0.01^{B}	2.07±0.10^{C}	2.27±0.11^{C}	
Coliforms were not detected							

Mean ± SE with different small letters column-wise and capital letters row-wise as superscripts differ significantly (P<0.05), N =6

Overall mean value for total plate count (TPC) (log cfu/g) of T_0, T_1 and T_2 were 3.43±0.15, 2.82±0.10 and 2.72±0.12, respectively (Table-05). During storage, an overall significant (P<0.05) increase in TPC was observed in all the treatments. The results of the present study could be collated with the observations of Rovida (2016) in mutton nuggets and Qureshi (2017) in spent hen patties. The psychrophillic count was not detected up to 10 days of storage in all the treatments and thereafter, it increased significantly in all the treatments throughout the storage. The non-observance of psycrophiles during early period of storage could be due to thorough cooking, good hygiene and absence of post processing contamination. The results are in agreement with Kumar *et al.* (2015) who could not detect psychrophilic count up to 14th day of storage. Good hygienic practices implemented during handling, processing packaging and analysis of products could be the reason for absence of coliforms. A similar observation was reported by Kumar *et al.* (2015), who reported no coliform count during whole storage period in pork patties.

CONCLUSION

The improvement in the functionality of meatballs (Rista) using dietary fiber sources like wheat bran and antioxidant sources like grape seed extract can be taken up by the food industry, because it did not deteriorate the storage quality of the product under aerobic conditions for at least 16 days at refrigeration temperature.

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COMPETING INTERESTS

No competing interests are involved

ETHICS STATEMENT

No ethics issue is involved.

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