TÜBİTAK

Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2015) 39: 493-500
© TÜBİTAK
doi:10.3906/vet-1406-93

Storage stability of aerobically packaged extended dehydrated chicken meat rings at ambient temperature

Bidyut Prava MISHRA[1,*], Geeta CHAUHAN[1], Sanjod Kumar MENDIRETTA[1], Prasana Kumar RATH[2], Renuka NAYAR[1]

[1]Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

[2]Department of Veterinary Pathology, College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Received: 29.06.2014 • **Accepted/Published Online:** 06.04.2015 • **Printed:** 28.08.2015

Abstract: The present study was conducted to evaluate the storage stability of aerobically packaged extended dehydrated chicken meat rings during ambient storage at 30 ± 2 °C. Extended dehydrated chicken meat rings were prepared by utilizing spent hen meat (80%), an optimized level of rice flour, refined wheat flour, potato starch, spice mix, common salt, and sodium tripolyphosphate. The control product was prepared in a similar manner except that rice flour was substituted by an equal quantity of spent hen meat. The products were aerobically packaged in low-density polyethylene (LDPE) pouches and analyzed for physicochemical, microbiological, and sensory characteristics at regular intervals of 0, 15, 30, and 45 days during storage. Significant ($P < 0.01$) effects of treatments on the moisture content, thiobarbituric acid reacting substance (TBARS) value, peroxide value, total plate count, and yeast and mold count and also on the pH ($P < 0.05$) of the products were noticed. Days of storage significantly ($P < 0.01$) affected pH value, moisture content, TBARS value, peroxide value, appearance (of both dried and rehydrated and cooked products), flavor, texture, meat flavor intensity, and juiciness and also affected the overall acceptability ($P < 0.05$) of the products during storage. Treatment × storage days interaction significantly ($P < 0.01$) affected moisture content of the dehydrated chicken meat rings during storage. These observations indicated that the product can be stored in aerobically packaged LDPE pouches for 45 days without much change in physicochemical, microbiological, and sensory properties.

Key words: Dehydrated chicken meat ring, spent hen meat, storage study

1. Introduction

Meat and meat products are good sources of all essential amino acids and a major source of B-complex vitamins and minerals. However, due to the intrinsic properties of fresh meat like relatively high water activity, slightly acidic pH, and the availability of carbohydrates (glycogen) and proteins, it becomes a good substrate for microbial growth and consequently a highly perishable commodity. The shelf life of meat products is limited by enzymatic and microbiological spoilage. Their high perishability causes their storage and marketing demanding considerable amounts of energy input in terms of refrigeration and freezing, which is costly and scanty in India and other developing countries. Drying is considered as the commonest method of food preservation (1). It can be defined as a simultaneous heat and mass transfer operation in which the water activity of material is lowered by removal of water to a certain level so that microbial spoilage is avoided. Some studies had also been conducted on chicken products with lowered water activity like chicken snacks (2), chicken chips (3), popped cereal snacks with spent hen meat (4), dehydrated chicken pulav (5), dehydrated chicken kebab mix (6), dehydrated chicken chunks (7), etc.

Increasing interest is being shown towards the partial replacement of meat systems with extenders/binders/fillers in order to minimize the product cost while improving or at least maintaining nutritional and sensory qualities of end products that consumers expect. Cereals, millets, and nonmeat proteins added to meat products as extenders improve yield, texture, and palatability and reduce the cost of production. Use of rice flour in meat products held meat tissues, meat juices, and fat together during storage and cooking (8). Rice is relatively free of toxic substances and the protein efficiency ratio (ratio of weight gain to protein consumed on a 10% protein diet) of rice (at 2.18) is almost equivalent to that of beef (at 2.30) (9). Rice flour could be used successfully in comminuted meat products for improving texture, flavor, and color of the products (10). It is often used in batter systems as it is

* Correspondence: bidyutmishraivri@gmail.com

known to be a healthier alternative providing fewer calories (11). Several researchers have studied the use of rice flour in meat products including rice and turkey meat blend papads (12), chicken snacks (2), chicken patties (13), and chicken nuggets (14). To extend the shelf life of the product, packaging is an important tool. Packaging can lower the weight loss and cost of transportation and can increase the shelf life of food products (15). In view of the above-mentioned facts, the present research study was planned to study the effect of aerobic packaging on the quality characteristics of extended dehydrated chicken meat rings during storage at ambient temperature (30 ± 2 °C).

2. Materials and methods

Dressed spent hens (more than 72 weeks old) were obtained from the Central Avian Research Institute, Izatnagar, and were deboned manually. All separable fat, fascia, and connective tissue were trimmed off from leg and breast muscles. Lean meat was cut into cubes of approximately 2.5 × 1.25 × 1.25 cm, minced twice through an 8-mm sieve in a meat mincer (Santos, France), mixed with sodium tripolyphosphates (0.3 g/100 g of raw meat), and steam cooked at 121 °C and 15 psi pressure for 30 min. It was then cooled to room temperature, mixed with salt (1 g), and blended for 30 s. Potato starch (3%), refined wheat flour (7%), garlic (2 g), spice mixture (1.5 g), Kashmiri chili (mirch) powder (0.7 g), and 10% rice flour (1:1 hydration, w/w) were added and the mixture was further blended for 1 min to make it uniform. The control product had only 90% chicken meat and no rice flour, while the treatment product was composed of 10% rice flour and 80% chicken meat, respectively. Ingredients of the main mix in this study consisted of chicken meat (90%), refined wheat flour (7%), and potato starch (3%). Additives such as salt, garlic, spice mixture, and Kashmiri mirch powder were added in as quantity in grams per 100 grams of main mixture. The spice mix powder used in this study was prepared by grinding oven-dried (60 °C overnight) ingredients: coriander 17%, cumin seed 10%, aniseed 10%, black pepper 10%, caraway 10%, turmeric 10%, dried ginger 10%, capsicum 8%, cardamom 5%, cinnamon 5%, cloves 3%, nutmeg 1%, and mace 1%. All the spice ingredients were purchased from a local market of Bareilly, Uttar Pradesh, India. The batter obtained was steam-cooked without pressure for 30 min and was allowed to cool at room temperature. Portioning of the batter was then done at 14 g each. Each portioning was placed inside a plastic mold to prepare meat rings of approximately 3 cm in diameter and 1 cm in thickness. After being shaped, the rings were placed in a preheated hot-air oven for drying at 60 °C for 18 h and then cooled at room temperature. Extended dehydrated chicken meat rings with rice flour as extender and control products without rice flour were aerobically packaged in low-density polyethylene (LDPE) pouches separately and stored at ambient temperature.

The storage stability of the product was evaluated up to 45 days at regular intervals of 0, 15, 30, and 45 days for physicochemical, microbiological, and sensory characteristics.

2.1. Physicochemical analysis

2.1.1. Rehydration ratio

The weight of a few dried rings was noted. These rings were rehydrated in 1:5 volumes of water at room temperature for 30 min. The rehydrated rings were weighed after mopping the excess water on the surface by tissue paper and the rehydration ratio was calculated as follows.

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated rings}}{\text{Weight of dry rings}}$$

2.1.2. pH

Ten grams of sample (after grinding in a home mixer for 1 min) was blended with 50 mL of distilled water for 1 min using an Ultra Turrax tissue homogenizer (Model T25, Janke & Kenkel, IKA Labortechnik, Germany). The pH of the homogenate was recorded by immersing the combined glass electrode of a digital pH meter (pH Tutor, Eutech Instruments, the Netherlands).

2.1.3. Water activity

Water activity was measured with the help of a water activity meter (Hygrolab 3, Rotronics, Switzerland). A ground sample was taken in the sample container of the water activity meter and was introduced inside the meter; the upper lid was closed and the button was pressed. The reading was recorded in 'quick mode' and noted after the beep sound. It took 5–6 min to take one reading.

2.1.4. Thiobarbituric acid reacting substances (TBARS) number

The TBARS number of samples was determined by using the distillation method described by Tarladgis et al. (16). The optical density was recorded at 538 nm using a spectrophotometer (DU 640 spectrophotometer, Beckman, USA). The optical density was multiplied by a factor of 7.8 and TBARS value was expressed as mg malondialdehyde/kg of sample as suggested by Koniecko (17).

2.1.5. Moisture

Moisture content of dehydrated chicken meat rings was determined by the procedures prescribed by the Association of Official Analytical Chemists (18) using a hot-air oven.

2.1.6. Peroxide value

Twenty grams of ground sample was homogenized for 2 min at low speed in an Ultra Turrax tissue homogenizer after adding 5 g of sodium sulfate and 137 mL of chloroform. The mix was filtered through Whatman No. 1 filter paper

containing one scoop of sodium sulfate, and 25 mL of filtrate was taken in a preweighed beaker for recording fat weight after evaporating away the chloroform. An aliquot of 25 mL was taken in a conical flask and allowed to react with 30 mL of glacial acetic acid and 2 mL of saturated potassium iodide solution with occasional swirling. After 2 min, 100 mL of distilled water was added to stop the reaction, and then 2 mL of 1% starch (potato starch) indicator solution was added and titration was carried out against 0.01 N sodium thiosulfate solutions until the blue color disappeared (17).

$$\text{PV (mEq/1000 g fat)} = \frac{\text{Normality of sodium thiosulfate} \times \text{volume of sodium thiosulfate}}{\text{Fat weight}} \times 1000$$

2.2. Microbiological analysis

All the microbiological parameters were determined by following the standard methods of the APHA (19). Ready-made media (Hi-Media, SRL, India) were used for all the microbiological examination. Ten grams of sample was transferred to a presterilized Stomacher bag with 90 mL of sterile 0.1% peptone water (Hi-Media) and stomached in the Stomacher for 1 min at the speed of 8. A 10-fold serial dilution was subsequently prepared. Appropriate dilutions were poured onto plate count agar, potato dextrose agar, and violet red bile agar (Sisco Research Laboratories Pvt. Ltd., India) for total plate count (TPC), yeast and mold count, and coliform count, respectively. The plates were then incubated at 35 °C for 48 h for TPC and coliform count and at 25 °C for 5 days for yeast and mold count. Plates showing 30–300 colonies were counted. The number of colonies was multiplied by the reciprocal of the dilution and expressed as $\log_{10}$ cfu/g.

2.3. Sensory evaluation

Sensory evaluation of chicken meat rings was conducted using an 8-point descriptive scale (20) with slight modifications, where 8 = excellent and 1 = extremely poor. The experienced panel consisting of scientists and postgraduate students of the Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar, evaluated the samples. The panelists were briefed about the nature of the experiments without disclosing the identity of the samples and were requested to rate them on an 8-point descriptive scale on the sensory evaluation proforma for different attributes. Meat rings after rehydration and steam cooking were served to the panelists. Water was provided to rinse the mouth between tasting of each sample. The panelists evaluated the samples for attributes such as appearance, flavor, texture, meat flavor intensity, juiciness, and overall acceptability.

2.4. Statistical analysis

The experiment was replicated three times for all experiments. Data generated from various trials under each experiment were pooled and compiled and analyzed using SAS (SAS Institute Inc., USA). Means and standard errors were computed for each parameter. The data were subjected to analysis of variance, least significant difference test, and Tukey test for comparing the means to find the effects between treatments, storage periods, and their interactions for various parameters in different experiments. The smallest difference (D5%) for two means to be significantly different ($P < 0.05$) was reported.

3. Results

3.1. Physicochemical characteristics

The mean values for different physicochemical parameters of dehydrated chicken meat rings with an optimum level of rice flour and control products are presented in Table 1. The pH levels decreased gradually during the entire period of storage and significant ($P < 0.05$) decrease was observed in the control product on day 30 and the treatment on day 45. The pH level of the control product on day 45 was significantly ($P < 0.05$) lower than the initial value but remained comparable with the levels on days 15 and 30 of storage. The pH value of the treated product on day 45 was significantly ($P < 0.05$) lower than the value on days 0 and 15 of storage but remained comparable with day 30 of storage. The pH values of the control and treatment were comparable to each other on days 0, 15, and 45 of storage, whereas on day 30 of storage the treatment had a significantly ($P < 0.05$) higher value than the control. The value of the rehydration ratio in control and treated products did not show any significant change ($P > 0.05$) during the entire period of storage. The moisture value followed a significant ($P < 0.05$) decreasing trend at subsequent storage intervals up to day 30 of storage in the control product and thereafter it decreased nonsignificantly ($P > 0.05$) at day 45 of storage. The moisture content of the control product on day 45 was significantly ($P < 0.05$) lower than the content on days 0 and 15 of storage. The moisture content of the treated product on day 45 was significantly ($P < 0.05$) lower than on days 0 and 15 of storage, whereas it remained comparable with value of day 30 of storage. However, significantly ($P < 0.05$) lower values of moisture in the treatment than the control were observed at every study interval during storage. The average value for water-holding capacity of control and treated products indicated a decreasing trend during storage of the product; however, the difference was nonsignificant ($P > 0.05$) statistically. In addition, there was no significant difference ($P > 0.05$) between water-holding capacity of the control and treatment on any particular day of storage. The peroxide value of the control product increased significantly ($P <$

Table 1. Changes in the physicochemical characteristics of aerobically packaged control and selected treatment products during storage at ambient temperature (mean ± SE)*.

Attributes	Days of storage			
	Day 0	Day 15	Day 30	Day 45
pH				
Treatment	6.26 ± 0.01 ^{a}	6.25 ± 0.05 ^{a}	6.19 ± 0.03 ^{ab1}	6.06 ± 0.09 ^{b}
Rehydration ratio				
Control	1.56:1 ± 0.03	1.56:1 ± 0.03	1.57:1 ± 0.02	1.60:1 ± 0.04
Treatment	1.54:1 ± 0.01	1.55:1 ± 0.03	1.57:1 ± 0.04	1.59:1 ± 0.04
Moisture (%)				
Control	7.20 ± 0.03 ^{a1}	6.34 ± 0.09 ^{b1}	5.89 ± 0.02 ^{c1}	5.67 ± 0.07 ^{d1}
Treatment	5.60 ± 0.02 ^{a2}	5.40 ± 0.06 ^{b2}	5.30 ± 0.03 ^{b2}	5.18 ± 0.02 ^{c2}
Water-holding capacity (%)				
Control	173.66 ± 2.52	173.54 ± 2.36	171.59 ± 2.52	170.24± 2.31
Treatment	177.57 ± 2.82	176.05 ± 2.64	174.53 ± 2.40	172.61 ± 2.48
TBARS values (mg malonyldialdehyde/kg)				
Control	0.86 ± 0.06 ^{c1}	1.63 ± 0.11 ^{b}	2.186 ± 0.23 ^{a1}	1.91 ± 0.22 ^{ab}
Treatment	0.63 ± 0.08 ^{b2}	1.46 ± 0.09 ^{a}	1.61 ± 0.09 ^{a2}	1.48 ± 0.09 ^{a}
Peroxide value (mEq O_2/kg)				
Control	5.29 ± 0.02 ^{d1}	7.75 ± 0.08 ^{c1}	8.13 ± 0.17 ^{b1}	8.75 ± 0.17 ^{a1}
Treatment	4.09 ± 0.05 ^{c2}	5.19 ± 0.329 ^{b2}	5.97 ± 0.40 ^{b2}	7.27 ± 0.50 ^{a2}

*Means ± standard errors (SE) with different superscripts row-wise (letters) and column-wise (numbers) differ significantly ($P < 0.05$) (n = 6 for each treatment).

0.05) on day 15 of storage as compared to the initial value and thereafter it remained almost stable up to day 30 and then increased significantly ($P < 0.05$) on day 45 of storage. The peroxide value of treated product remained comparable up to day 15 of storage and then increased nonsignificantly ($P > 0.05$) up to day 45 of storage. The peroxide value of treated product on day 45 was significantly ($P < 0.05$) higher than the value on days 0 and 15 of storage but remained comparable with the value on day 30 of storage. However, there were significantly ($P < 0.05$) lower values of peroxide in the treatment than the control during the entire period of storage. The TBARS value increased significantly ($P < 0.05$) on day 15 of storage as compared to the initial value and thereafter it remained comparable up to day 30 of storage, and then a nonsignificant ($P > 0.05$) decrease in TBARS value was observed on day 45 of storage in both the control and treated products. However, there was significantly ($P < 0.05$) lower value of TBARS in the treatment than the control at days 0 and 30 of storage.

3.2. Microbiological characteristics

The mean values for different microbiological parameters are presented in Table 2. During the whole storage period, TPC for the control was higher than that of the treatment. No coliforms were detected throughout the storage study. Yeast and molds were not detected on day 0 of ambient storage in both control and treated products but they increased significantly on day 15 of storage and thereafter remained stable up to day 30 of storage and then increased significantly ($P < 0.05$) on day 45 of storage in the control product. In the treated product, there was significant ($P < 0.05$) increase in yeast and molds with subsequent storage interval. The yeast and mold counts for control and treatment products were comparable on day 15 of storage, but yeast and mold counts of the treatment on days 30 and 45 of storage were significantly ($P < 0.05$) lower than those of the control.

3.3. Sensory qualities

Mean sensory scores of products are presented in Table 3. The score for appearance (dried product) in the control

Table 2. Changes in the microbiological qualities of aerobically packaged control and selected treatment products during storage at ambient temperature (mean ± SE)*.

Attributes	Days of storage			
	Day 0	Day 15	Day 30	Day 45
Total plate count (log cfu/g)				
Control	2.93 ± 0.02 ^{d1}	3.41 ± 0.01 ^{c1}	4.16 ± 0.00 ^{b1}	5.18 ± 0.02 ^{a1}
Treatment	2.75 ± 0.02 ^{d2}	3.04 ± 0.05 ^{c2}	3.81 ± 0.09 ^{b2}	4.96 ± 0.04 ^{a2}
Yeast and mold count (log cfu/g)				
Control	ND	1.15 ± 0.20 ^{c}	1.57 ± 0.12 ^{b1}	2.04 ± 0.02 ^{a1}
Treatment	ND	0.85 ± 0.07 ^{c}	1.13 ± 0.06 ^{b2}	1.58 ± 0.03 ^{a2}
Coliform count (log cfu/g)				
Control	ND	ND	ND	ND
Treatment	ND	ND	ND	ND

*Means ± standard errors (SE) with different superscripts row-wise (letters) and column-wise (numbers) differ significantly ($P < 0.05$) (n = 6 for each treatment). ND = Not detected.

showed a progressive nonsignificant decline ($P > 0.05$) with increase in storage period up to day 30 but scores decreased significantly ($P < 0.05$) on day 45 of storage. The score of treatment for appearance was almost stable up to day 30 but scores decreased significantly ($P < 0.05$) on day 45. In addition, there was no significant difference ($P > 0.05$) in the appearance score between control and treatment on any particular day of storage. The sensory scores of the control for appearance of rehydrated and cooked meat rings were comparable up to day 15 of storage but thereafter decreased ($P < 0.05$) with progressive increase in period of storage. Appearance scores for rehydrated and cooked meat rings of the treatment were comparable to the control during the entire period of storage. Furthermore, in the case of treatment product, no significant difference ($P > 0.05$) was observed among the scores at any particular day of storage. The flavor score was comparable up to day 15 of storage but thereafter it decreased ($P < 0.05$) with progressive increase in period of storage in the control product. The flavor scores in the treated product remained comparable up to day 30 of storage and thereafter decreased significantly ($P < 0.05$) on day 45 of storage. Flavor score for the treatment was comparable to the control during the entire period of storage. The texture score of the control product was almost stable up to day 15 and thereafter decreased ($P < 0.05$) with progressive increase in period of storage. In treated product, the score remained comparable up to day 30 of storage and then decreased significantly on day 45 of storage. In addition, there was no significant difference ($P > 0.05$) in the texture score between control and treatment on any particular day of storage. Meat flavor intensity score for the control on day 30 was significantly ($P < 0.05$) lower than the initial value but remained comparable with scores on days 15 and 45 of storage, whereas in the treatment product, the score remained comparable up to day 30 of storage and then decreased significantly ($P < 0.05$) on day 45. In addition, there was no significant difference ($P > 0.05$) in the meat flavor intensity score between the control and treatment on any particular day of storage. The juiciness score for the control and treated product remained comparable up to day 15 of storage and later on it decreased with progressive increase in period of storage. Juiciness score for the control on day 45 was significantly ($P < 0.05$) lower than scores on days 0 and 15 of storage, but it remained comparable with the score on day 30 of storage. In addition, there was no significant difference ($P > 0.05$) in the juiciness score between the control and treatment on any particular day of storage. Scores for overall acceptability of control product remained comparable up to day 30 of storage and thereafter decreased significantly ($P < 0.05$) on day 45 of storage, whereas there was no significant difference observed in the overall acceptability score for treated product throughout the entire storage period.

4. Discussion

4.1. Physicochemical characteristics

The pH scores decreased gradually during the entire period of storage and the present findings agreed with the results of Modi et al. (6) during the storage of dehydrated

Table 3. Changes in the sensory attributes of aerobically packaged control and treatment products during storage at ambient temperature (mean ± SE)*.

Attributes	Days of storage			
	Day 0	Day 15	Day 30	Day 45
Appearance (dried product)				
Control	7.03 ± 0.08 [a]	6.90 ± 0.11 [a]	6.88 ± 0.80 [a]	6.27 ± 0.16 [b]
Treatment	6.97 ± 0.11 [a]	7.08 ± 0.09 [a]	6.93 ± 0.07 [a]	6.56 ± 0.11 [b]
Appearance (cooked product)				
Control	7.00 ± 0.05 [a]	6.86 ± 0.10 [a]	6.53 ± 0.10 [b]	6.53 ± 0.10 [b]
Treatment	7.00 ± 0.10 [a]	6.96 ± 0.08 [a]	6.69 ± 0.08 [b]	6.68 ± 0.10 [b]
Flavor				
Control	6.80 ± 0.07 [a]	6.90 ± 0.09 [a]	6.50 ± 0.11 [b]	6.25 ± 0.07 [c]
Treatment	6.83 ± 0.16	6.86 ± 0.10 [a]	6.66 ± 0.10 [ab]	6.36 ± 0.10 [b]
Texture				
Control	6.88 ± 0.09 [a]	6.95 ± 0.10 [a]	6.52 ± 0.08 [b]	6.23 ± 0.09 [c]
Treatment	6.84 ± 0.11 [a]	6.88 ± 0.10 [a]	6.53 ± 0.10 [b]	6.38 ± 0.09 [b]
Meat flavor intensity				
Control	6.92 ± 0.09 [a]	6.87 ± 0.10 [a]	6.57 ± 0.08 [b]	6.38 ± 0.08 [b]
Treatment	6.76 ± 0.11 [a]	6.78 ± 0.11 [a]	6.47 ± 0.09 [b]	6.33 ± 0.06 [b]
Juiciness				
Control	6.63 ± 0.09 [a]	6.75 ± 0.10 [a]	6.30 ± 0.07 [b]	6.28 ± 0.10 [b]
Treatment	6.57 ± 0.15 [a]	6.74 ± 0.11 [a]	6.25 ± 0.07 [b]	6.23 ± 0.07 [b]
Overall acceptability				
Control	6.78 ± 0.09 [a]	6.70 ± 0.06 [ab]	6.52 ± 0.08 [bc]	6.43 ± 0.11 [c]
Treatment	6.74 ± 0.11	6.73 ± 0.09	6.61 ± 0.12	6.50 ± 0.10

*Means ± standard errors (SE) with different superscripts row-wise (letters) and column-wise (numbers) differ significantly ($P < 0.05$).

kebab mix; of Bennani et al. (21) for kaddid, a salted, dried mutton; and Rubio et al. (22) for a dry cured Spanish sausage, salchichon. The decreasing trend in pH value was attributed to the chemical activity as hydrolytic rancidity increases free fatty acid level but not to the microbial activity. The storage period had no effect on the value of rehydration ratio in control and treated products and similar results were reported by Kharb and Ahlawat (23) during storage of dehydrated chicken meat mince at ambient temperature for 60 days. Lower values of moisture in the treatment than the control were observed at every study interval during storage. Similar findings observed in chicken snacks during ambient storage were reported by Singh et al. (24). The water-holding capacity of the control and treatment gradually decreased with storage days and this is in agreement with Wariss (25), who stated that lowering of pH can cause reduced water binding. However, lower values of peroxide were observed in the treatment than the control during the entire period of storage. This may be due to high fat in the control. The higher peroxide value might be due to the presence of oxygen, and dehydrated meat products are susceptible to oxidative rancidity (26). Increase in yeast and mold counts in the present study might also be attributed to an increase in peroxide values. The present findings of higher peroxide value might be related to similar findings in dehydrated chicken pulav stored at ambient temperature as reported by Das and Jayaraman (5). The initial high TBARS value

observed might be due to the mincing, mixing, cooking, and drying steps involved in the preparation process, which resulted in extensive destruction of cellular structure, allowing the mixing of various meat constituents and prooxidants. Nassu et al. (27) reported a similar trend in TBARS values during storage of fermented goat meat sausage, which was attributed to the reactions of malonyldialdehyde with proteins.

4.2. Microbiological characteristics

During the whole storage period, TPC for the control was higher than for them treatment, which could be due to the higher level of lean meat, a good medium for growth of microorganisms and also the higher moisture content. Higher total plate counts were observed in aerobic packaging on all days of storage and this might be due to the higher oxygen levels in the product atmosphere and the absence of antimicrobial agents. These results are in agreement with that of Singh et al. (24), who also reported an increase in total plate counts in aerobically packed chicken snacks stored at ambient temperature. No coliforms were detected throughout the storage study. Das and Jayaraman (5) had reported absence of coliforms during ambient temperature storage of dehydrated chicken pulav. The absence of yeast and mold count on day 0 of storage might be due to the low water activity at the initial stage. Singh et al. (24) observed an increase in yeast and mold counts in aerobically packed chicken snacks stored at ambient temperature.

4.3. Sensory qualities

There was a decreasing trend observed in appearance (dried product) of the products during storage. Das and Jayaraman (5) reported a significant ($P < 0.05$) decrease in color of dehydrated chicken pulav during storage at ambient temperature and nonsignificantly ($P > 0.05$) at chiller temperature. Flavor score for treatment was comparable to the control during the entire period of storage. The progressive decrease in flavor scores could be correlated to an increase in TBARS number and free fatty acids in the meat products (16) under aerobic conditions. Decrease in moisture and pH on subsequent storage days favors the growth of microbes causing oxidative rancidity, thereby increasing the TBARS value, which might be attributed to a decrease in flavor scores in the present study. Kharb et al. (28) reported a nonsignificant ($P > 0.05$) decrease in flavor scores for dehydrated spent hen meat mince in ambient temperature storage. The texture score of product was decreased with progressive increase in period of storage. Singh et al. (24) reported a nonsignificant ($P > 0.05$) decrease in the texture scores in snacks containing broiler spent hen meat, rice flour, and sodium caseinate. Smith et al. (29) also reported no difference in mouth feel, taste, and texture of fermented beef snack during storage at room temperature (24 °C) for about 30 days. The decrease in flavor scores corroborates with the findings of Sharma and Nanda (3), who reported significant decrease in meat flavor intensity during vacuum-packaged storage of chicken chips at ambient temperature. The trend in juiciness score might probably be due to the interaction between meat and rice flour and rehydration of the meat rings. Modi et al. (6) reported that juiciness of chicken kebabs prepared from dehydrated mix was affected by the levels of starch and milk powder and the interaction between the two. Modi and Prakash (30) reported that maize flour had a decreasing effect on the juiciness of extended and dehydrated meat cubes after rehydration. The decrease in overall acceptability could be due to increase in lipid oxidation, pigment oxidation, and degradation of proteins and fats in dehydrated chicken meat rings over the period of storage. Kharb et al. (28) observed a nonsignificant decrease in the acceptability of dehydrated chicken meat mince during storage. Das and Jayaraman (5) reported a significant decrease in overall acceptability of dehydrated chicken pulav during storage at ambient temperature and nonsignificantly at chiller temperature.

Based on the results, it could be concluded that the product can be stored in aerobically packaged LDPE pouches for 45 days without much change in physicochemical, microbiological, and sensory properties.

References

1. Vadivambal R, Jayas DS. Changes in quality of micro wave-treated agricultural products - a review. Biosyst Eng 2007; 98: 1–16.
2. Singh VP, Sanyal MK, Dubey PC. Quality of chicken snack containing broiler spent hen meat, rice flour and sodium caseinate. J Food Sci Technol 2002; 39: 442–444.
3. Sharma BD, Nanda PK. Studies on the development and storage stability of chicken chips. Indian J Poult Sci 2002; 37: 155–158.
4. Lee SO, Min JS, Kim IS, Lee M. Physical evaluation of popped cereal snacks with spent hen meat. Meat Sci 2003; 64: 383–390.
5. Das H, Jayaraman S. A study on the quality and stability of convenience dehydrated chicken pulav. J Food Sci Technol 2003; 40: 97–101.
6. Modi VK, Sachindra NM, Nagegowda P, Mahendrakar NS, Rao DN. Quality changes during the storage of dehydrated chicken kebab mix. Int J Food Sci Technol 2007; 42: 827–835.

7. Hameed RS, Kanchana S, Vennila P, Hemalatha G. Storage stability of dehydrated chicken chunks in different packaging materials. Indian Vet J 2007; 84: 1283–1285.

8. Kerr RW. Chemistry and Industry of Starch. 2nd ed. New York, NY, USA: Academic Press; 1950.

9. Hansen LP, Hosek R, Callan M, Jones FT. The development of high protein rice flour for early childhood feeding. Food Technol 1981; 35: 38–42.

10. Council of Australian Food Technology Associations Rice Flour Used Successfully in Emulsified Fresh Sausage. Food Technology in Australia 1986; 38: 229.

11. Yokoyama W. Nutritional properties of rice and rice bran. In: Champagne ET, editor. Rice: Chemistry and Technology. St. Paul, MN, USA: American Association of Cereal Chemists; 2004. pp. 595–609.

12. Berwal JS, Dhanda JS, Berwal RK. Studies on rice and turkey meat blend papads. J Food Sci Technol 1996; 33: 237–239.

13. Kumar RR, Sharma BD. Evaluation of the efficacy of sorghum flour as extender in chicken patties. Indian J Meat Sci 2005; 3: 17–20.

14. Dogan SF, Sahin S, Sumnu G. Effects of soy and rice flour addition on batter rheology and quality of deep-fat fried chicken nuggets. J Food Eng 2005; 71: 127–132.

15. Rozbeh M, Kalchayanand N, Field RA, Johnson MC, Ray B. The influence of bio preservatives on the bacterial level of refrigerated vacuum packaged beef. J Food Safety 1993; 13: 99–111.

16. Tarladgis BG, Watts BM, Younathan MT, Dugan LR. A distillation method for the quantitative determination of malonaldehyde in rancid foods. J Am Oil Chem Soc 1960; 37: 44–48.

17. Koniecko EK. Handbook for Meat Chemists. Wayne, NJ, USA: Avery Publishing Group; 1979.

18. AOAC. Official Methods of Analysis. 16th ed. Rockville, MD, USA: AOAC; 1995.

19. APHA. Compendium of Methods of Microbiological Examination of Foods. 4th ed. Washington, DC, USA: APHA; 2001.

20. Keeton JT. Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. J Food Sci 1983; 48: 878–881.

21. Bennani L, Faid M, Bouseta A. Experimental manufacturing of kaddid, a salted dried meat product: control of the microorganisms. Eur Food Res Technol 2000; 211: 153–157.

22. Rubio B, Martinez B, Sanchez MJ, Garcia-Cachan MD, Rovira J, Jaime I. Study of shelf life of a dry fermented sausage "salchichon" made from raw material enriched in monounsaturated and polyunsaturated fatty acids and stored under modified atmospheres. Meat Sci 2007; 76: 128–137.

23. Kharb R, Ahlawat SS. Effect of pre cooking and spices on quality characteristics of dehydrated spent hen meat mince. Indian J Poult Sci 2010; 45: 100–102.

24. Singh VP, Mendiratta SK, Agarwal RK, Sanyal MK, Dubey PC. Storage stability of aerobically packaged chicken snacks at ambient temperature. J Vet Public Health 2009; 7: 45–51.

25. Wariss PD. Meat Science-An Introductory Text. 2nd ed. Cambridge, UK: Cambridge University Press; 2010.

26. Rahman MS, Labuza TP. Water activity and food preservation. In: Rahman MS, editor. Handbook of Food Preservation. 2nd ed. New York, NY, USA: Taylor and Francis; 2007. pp. 447–476.

27. Nassu RT, Goncalves LAG, Da Silva MAAP, Beserra FJ. Oxidative stability of fermented goat meat sausage with different levels of natural antioxidant. Meat Sci 2003; 63: 43–49.

28. Kharb R, Ahlawat SS, Sharma DP. Studies on shelf life of dehydrated spent hen meat mince. Indian J Poult Sci 2008; 43: 213–215.

29. Smith GL, Stalder JW, Keeton JT, Papadopoulos LS. Evaluation of partially defatted chopped beef in fermented beef snack sausage. J Food Sci 1991; 56: 348–351.

30. Modi VK, Prakash M. Quick and reliable screening of compatible ingredients for the formulation of extended meat cubes using Plackett-Burman design. Lebensm-Wiss u-Technol 2008; 41:878–882.