Indian Journal of Animal Sciences **84** (11): 1222–1227, November 2014/Article
https://doi.org/10.56093/ijans.v84i11.44792

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

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Received: 19 October 2013; Accepted: 27 July 2014

ABSTRACT

Extended dehydrated chicken meat rings were prepared by utilizing spent hen meat (80%), optimized level of rice flour, refined wheat flour, potato starch, spice mix, common salt and sodium tripolyphosphates. The control product was prepared in a similar manner except that rice flour substituted by equal quantity of spent hen meat. The products were vacuum packaged in nylon-LDPE-aluminum foil-LDPE laminates and analyzed at regular interval of 0, 15, 30 and 45 days during ambient storage at 30±2°C. Significant effect of treatments on the moisture content, thiobarbituric acid reacting substances (TBARS value), peroxide value, total plate count (TPC), yeast and mould count and also on pH value of the products were noticed. Days of storage significantly affected pH value, moisture content, TBARS value, peroxide value, redness, yellowness, hue value, chroma value, TPC, yeast and mould count, appearance (of both dried and rehydrated and cooked products), flavour, texture, meat flavour intensity, juiciness and also on overall acceptability of the products. Treatment × storage days interaction significantly affected moisture content of the dehydrated chicken meat rings during storage.

Key words: Dehydrated chicken meat ring, Spent hen meat, Storage study

Extended dehydrated chicken meat ring is a meat based product having high nutritional value but more prone to development of rancidity and microbiological contaminations. Packaging is an important tool to extend the shelf life of the product. The present article reports about the effect of storage on physico-chemical, microbiological and sensory properties of vacuum packaged dehydrated chicken meat rings with optimum level of rice flour in nylon-LDPE-aluminium foil-LDPE laminates at ambient temperature (30±2°C).

MATERIALS AND METHODS

Dressed spent hens (more than 72 weeks old) were obtained from the Institute and deboned manually. Extended dehydrated chicken meat rings and control meat rings were prepared as per the formulation given in Table 1. All separable fat, fascia and connective tissue were trimmed off from leg and breast muscle. Lean meat was cut into cubes of approximately 2.5 cm ×1.25 cm ×1.25 cm which minced twice through 8 mm sieve in a meat mincer and mixed with sodium tri polyphosphates, steam cooked at 121ºC and 15 psi pressure for 30 min. Then cooled to room temperature, mixed with salt and blended for 30 sec. Potato starch, refined wheat flour, garlic, spice mixture, kashmiri mirch powder and rice flour (1:1 hydration, w/w) were added and further blended for 1 min to make the mixture uniform. Spice mix powder used in the study was prepared by grinding oven dried (60°C for overnight) ingredients, viz. coriander 17%, cumin seed 10%, aniseed 10%, black pepper 10%, caraway 10%, turmeric 10%, dried ginger 10%, capsicum 8%, cardamom 5%, cinnamon 5%, cloves

Table 1. Formulation for the preparation of extended dehydrated chicken meat rings

	Control	Extended dehydrated chicken meat rings
Rice flour	0	10
Chicken meat	90	80
Refined wheat flour	7	7
Potato starch	3	3
Other additives	Quantity (g/100 g of main mix)	
Salt	1	1
Garlic	2	2
Kashmiri mirch powder	0.7	0.7
Spice mixture	1.5	1.5

Sodium tripoly phosphates (0.3 g / 100 g of raw meat, used in meat cooking).

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3%, nutmeg 1% and mace 1%. The batter obtained was steam cooked without pressure for 30 min and allowed to cool to room temperature. After cooling, portioning of the batter was done (14 g each). Each portioning was placed inside a plastic mould to prepare the meat rings of approximately 3 cm diameter and 1cm thickness. After giving shape, the rings were placed in preheated hot air oven for drying at the temperature of 60°C for 18 h and then cooled to room temperature. Extended dehydrated chicken meat rings with rice flour as extender and control products without rice flour, vacuum packaged in nylon-LDPE-aluminum foil-LDPE laminates 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 physico-chemical, microbiological and sensory characteristics. pH and moisture were determined as per AOAC (1995). Rehydration ratio was determined as per Lewicki (1998). Water holding capacity was measured as per Wardlaw *et al.* (1973) with slight modifications and water holding capacity (as ml of 0.6 M sodium chloride solution retained by 100g of sample) was expressed as ml / 100g. Peroxide value was estimated as per Koniecko (1979). The TBARS number of samples was determined by using distillation method (Tarladgis *et al.* 1960). The colour was measured using a Lovibond tintometer. The hue and chroma values were determined using the formula, (tan–1) b/a (Little 1975) and $(a^2 + b^2)^{1/2}$ (Froehlich *et al.* 1983) respectively, where a, red unit and b, yellow unit. TPC, yeast, mould count (YMC) and coli form counts (CC) were determined as per APHA (2001). Sensory evaluation of chicken meat rings after rehydration and steam cooking for 10 min under 15 psi pressure was conducted using an 8 point descriptive scale (Keeton 1983) with slight modifications, where 8, excellent and 1, extremely poor. Data generated from various trials were analyzed by using SAS (Statistical Analysis Software, version 9.3.

RESULTS AND DISCUSSION

Physico-chemical characteristics: The mean values for different physico-chemical parameters of dehydrated chicken meat rings with optimum level of rice flour and control products are presented in Table 2. The pH value of treatment followed a significant (P<0.05) linear decreasing trend from 0 to 45th day of storage. In addition, there was no significant (P>0.05) difference in the pH value between control and treatment on any particular day of storage. The present findings agreed with the results of Modi *et al.* (2007) during the storage of dehydrated kebab mix and Gok *et al.* (2008) for Turkish pastrima. The decreasing trend in pH value attributed to the chemical activity as hydrolytic rancidity increases free fatty acid level but not to the microbial activity. The value of rehydration ratio in control and treated products did not show any significant (P>0.05) change during the entire period of storage and similar results were reported by Kharb and Ahlawat (2010) during storage of dehydrated chicken meat mince at ambient temperature for 60 days. The moisture value followed a significant (P<0.05) increasing trend up to 30th day of storage and then it remained almost stable up to 45th day of storage of both control and treated product. However, there was significantly (P<0.05) lower value of moisture in treatment than control at any particular day of storage. Similar findings observed in dehydrated chicken kebab mix during ambient

Table 2. Changes in physico-chemical characteristics of vacuum packaged control and treatment, during storage at ambient temperature (mean±SE)*

Attributes		Days of storage			
		0	15	30	45
pH					
	Control	6.22 ± 0.04^{a}	6.16 ± 0.04^{a}	5.99 ± 0.06^{ab}	5.80 ± 0.12^{b}
	Treatment	6.26 ± 0.01^{a}	6.19 ± 0.00^{b}	5.96 ± 0.00^{c}	5.89 ± 0.03^{d}
Rehydration ratio					
	Control	1.56±0.02	1.55±0.02	1.53±0.02	1.52±0.02
	Treatment	1.54±0.01	1.53±0.00	1.53±0.00	1.53±0.01
Moisture (%)					
	Control	7.20 ± 0.03^{c1}	7.52 ± 0.04^{b1}	7.73 ± 0.04^{a1}	7.79 ± 0.03^{a1}
	Treatment	5.60 ± 0.02^{c2}	5.86 ± 0.03^{b2}	5.88 ± 0.04^{a2}	6.18 ± 0.03^{a2}
Water holding capacity (ml/100g)					
	Control	173.66±2.52	173.13±2.61	171.04±2.10	170.08±2.10
	Treatment	177.57±2.82	176.15±2.39	174.16±2.27	172.88±2.14
Peroxide value (meq/kg of fat)					
	Control	5.29 ± 0.02^{a1}	4.47 ± 0.14^{b1}	4.37 ± 0.11^{b1}	3.80 ± 0.17^{c1}
	Treatment	4.09 ± 0.05^{a2}	3.78 ± 0.23^{ab2}	3.58 ± 0.14^{ab2}	3.27 ± 0.11^{b2}
TBARS values (mg malonaldehyde/kg)					
	Control	0.86 ± 0.06^{b1}	1.03 ± 0.08^{b}	1.80 ± 0.12^{a1}	1.51 ± 0.06^{a1}
	Treatment	0.63 ± 0.08^{2}	0.83±0.11	0.77 ± 0.11^{2}	0.70 ± 0.09^{2}

*Mean±SE with different superscripts row wise (alphabet) and column wise (numeral) differ significantly (P<0.05). (n =6 for each treatment).

storage after packaging in metalized polyester pouches as studied by Modi *et al.* (2007) and in vacuum packed hurdle treated caprine keema during ambient storage as observed by Karthikeyan *et al.* (2000). 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 statistically nonsignificant (P>0.05). In addition, there was no significant difference (P>0.05) between water holding capacity of control and treatment on any particular day of storage. This is in agreement with Wariss (2010) who stated that lowering of pH can cause reduced water binding. The peroxide value of control product followed a significantly (P<0.05) decreasing trend up to the 15th day of storage and thereafter it remained almost stable up to 30th day and then further decreased significantly (P<0.05) on 45th day of storage. The peroxide value of treated product remained stable up to 30th day of storage and thereafter it decreased significantly (P<0.05) on 45th day of storage. However, there was significantly (P<0.05) lower value of peroxide in treatment than control throughout the storage period. Replacement of lean meat by rice flour, generally rich in carbohydrate and contain negligible fat might be the reason for lowering the fat content in treated products which results a lower peroxide value in treated product than control. This study corroborates the findings of Mgbemere *et al.* (2011) who observed a lowering of peroxide value in vacuum-packed *kilishi* stored at both refrigeration and ambient temperatures. TBARS value for control showed a nonsignificant increase (P>0.05) up to 15th day of storage, then it increased significantly (P<0.05) on 30th day. The value on 45th day was significantly (P<0.05) higher than values on 0 and 15th day of storage but remained comparable with 30th day of storage. However, in treated product, the TBARS value increased nonsignificantly (P>0.05) on 15th day of storage and thereafter it decreased non-significantly (P>0.05) during the entire period of storage. However, there were significantly (P<0.05) lower values of TBARS in treatment than control at 0, 30th and 45th day of storage. 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 mixing of various meat constituents and pro-oxidants (Rhee and Myers 2003). Nassu *et al.* (2003) reported a similar trend in TBARS value during storage of fermented goat meat sausage which was attributed to the reactions of malonaldehyde with proteins. Nam and Ahn (2003) and Singh *et al.* (2011) had observed the reduced TBARS values in vacuum packaged irradiated raw turkey breast and chicken snacks respectively in comparison to aerobic packaging.

Colour characteristics: The mean values for different colour parameters are presented in Table 3. The redness value for control product remained almost stable up to 15th day of storage and thereafter it increased significantly (P<0.05) with progressive increase in period of storage. Redness value of the treated product followed a significant (P<0.05) linear increasing trend from 0 to 45th day of storage. Treatment had a significantly (P<0.05) higher redness value on 30 and 45 day of storage as compared to control. The higher redness value in treated product might be due to the sugar-amine browning reactions that occurred between meat proteins and rice flour and as well as surface dehydration (Hedrick *et al.* 1994). The increase in redness value with increase in storage period might be due to the lipid oxidation and the oxidised compounds reacting with amino acids causing non enzymatic browning (Karthikeyan *et al.* 2000). Yellowness value on 15th day was significantly (P<0.05) lower than value on 0 day, thereafter, it decreased nonsignificantly (P>0.05) with the progressive increase in the storage period. The yellowness value in treated product decreased significantly (P<0.05) with progressive increase in storage period. The yellowness value on 45th day of storage was significantly (P<0.05) lower than the value on 0 and 15th day of storage but remained comparable with the 30th day of storage. The decreased yellowness value

Table 3. Changes in colour values of vacuum packaged control and treatment, during storage at ambient temperature (mean±SE)*

Attributes		Days of storage			
		0	15	30	45
Redness					
	Control	2.20±0.03^{b}	2.25±0.02^{ab}	2.28±0.02^{a2}	2.32±0.03^{a2}
	Treatment	2.15±0.02^{d}	2.32±0.03^{c}	2.77±0.02^{b1}	3.1±0.04^{a1}
Yellowness					
	Control	5.48±0.03^{a}	5.07±0.03^{b}	5.03±0.02^{b}	4.97±0.02^{b}
	Treatment	5.43±0.04^{a}	5.20±0.05^{b}	5.08±0.04^{bc}	5.02±0.03^{c}
Hue					
	Control	68.13±0.30^{a}	66.11±0.29^{b}	65.59±0.15^{bc1}	64.99±0.37^{c1}
	Treatment	68.40±0.29^{a}	65.98±0.16^{b}	61.75±0.18^{c2}	58.28±0.34^{d2}
Chroma					
	Control	5.91±0.03	5.54±0.03^{2}	5.53±0.02^{2}	5.48±0.01^{2}
	Treatment	5.84±0.04^{ab}	5.69±0.06^{b1}	5.79±0.04^{ab1}	5.90±0.03^{a1}

*Mean±SE with different superscripts row wise (alphabet) and column wise (numeral) differ significantly (P<0.05). (n =6 for each treatment).

might have resulted due to increased redness value in both control and treatment products. However, there was no significant difference (P>0.05) between yellowness value of control and treatment on any particular day of storage. The hue value in control product decreased significantly (P<0.05) with progressive increase in storage period and value on 45th day of storage was significantly (P<0.05) lower than the value on 0 and 15th day of storage but remained comparable with the value on 30th day of storage. In treated products hue value decreased significantly (P<0.05) with progressive increase in period of storage. Treatment had a significantly (P<0.05) lower hue value on 30 and 45 days of storage as compared to control. The chroma value for control product decreased non significantly (P>0.05) with progressive increase in period of storage. The chroma value for treated product remained comparable up to 30th day and thereafter it nonsignificantly (P>0.05) increased on 45th day of storage. The treated product had significantly (P<0.05) higher chroma value on 15th, 30th and 45th days of storage as compared to control product.

Microbiological characteristics: The mean values for different microbiological parameters are presented in Table 4. The value for total plate count (TPC) was almost stable up to 15th day of storage in both the products. Later on, it increased significantly (P<0.05) in the entire period of the

Table 4. Changes in microbiological qualities of vacuum packaged control and treatment, during storage at ambient temperature (mean±SE)*

Attributes		Days of storage			
		0	15	30	45
Total plate count (log cfu/g)					
	Control	2.93±0.02^{c1}	3.04±0.06^{c1}	3.56±0.05^{b1}	3.81±0.05^{a}
	Treatment	2.75±0.02^{c2}	2.87±0.03^{c2}	3.30±0.02^{ab2}	3.54±0.13^{a}
Yeast and mould count (log cfu/g)					
	Control	ND	0.93±0.08^{c1}	1.50±0.05^{b}	2.84±0.03^{a1}
	Treatment	ND	0.70±0.00^{c2}	1.47±0.09^{b}	2.15±0.02^{a2}
Coli form count (log cfu/g)					
	Control	ND	ND	ND	ND
	Treatment	ND	ND	ND	ND

*Mean±SE with different superscripts row wise (alphabet) and column wise (numeral) differ significantly (P<0.05). (n =6 for each treatment).

Table 5. Changes in sensory characteristics of vacuum packaged control and treatment, during storage at ambient temperature (mean±SE)*

Attributes		Days of storage			
		0	15	30	45
Appearance (dried product)					
	Control	6.94±0.05^{a}	6.93±0.06^{a}	6.70±0.08^{ab}	6.60±0.13^{b}
	Treatment	6.97±0.06	6.96±0.03	6.86±0.08	6.75±0.11
Appearance (cooked product)					
	Control	6.98±0.05^{a}	7.05±0.08^{a}	6.66±0.09^{b}	6.63±0.09^{b}
	Treatment	7.00±0.12	7.00±0.08	6.86±0.10	6.74±0.07
Flavour					
	Control	6.91±0.08^{a}	6.87±0.06^{a}	6.62±0.08^{ab}	6.53±0.09^{b}
	Treatment	6.83±0.11	6.81±0.06	6.69±0.09	6.68±0.08
Texture					
	Control	6.86±0.07	6.84±0.11	6.81±0.08	6.70±0.09
	Treatment	6.84±0.07	6.81±0.07	6.79±0.07	6.72±0.07
Meat flavour intensity					
	Control	6.95±0.05^{a}	6.94±0.08^{a}	6.62±0.08^{b}	6.55±0.08^{b}
	Treatment	6.85±0.14	6.84±0.06	6.74±0.06	6.69±0.07
Juiciness					
	Control	6.74±0.06^{a1}	6.61±0.09^{ab}	6.50±0.06^{ab}	6.47±0.06^{b}
	Treatment	6.57±0.03^{a2}	6.53±0.03^{ab}	6.43±0.04^{bc}	6.39±0.03^{c}
Overall acceptability					
	Control	7.18±0.06^{a}	7.08±0.05^{a}	6.78±0.05^{b}	6.71±0.04^{b}
	Treatment	7.10±0.02^{a}	7.00±0.03^{a}	6.75±0.06^{b}	6.78±0.04^{b}

*Mean±SE with different superscripts row wise (alphabet) and column wise (numeral) differ significasntly (P<0.05). (n =6 for each treatment).

storage in both the products, whereas in treated product, the score on 45th day was significantly (P<0.05) higher than the value on 0 day and 15 days and remained comparable with the score on 30th day of storage. The treated product had significantly (P<0.05) lower TPC count on 0, 15 and 30th day of storage than the control. Singh *et al*. (2011) reported lower total plate counts in vacuum packed chicken snacks when compared to aerobically packed samples. Yeast and moulds were not detected on 0 day, but increased significantly (P<0.05) on 15th day of storage and with subsequent storage interval in both the products. The yeast and mould counts for control and treatment products were comparable on 30th day of storage, but yeast and mould count of treatment on 15th and 45th day of storage were significantly (P<0.05) lower than the control. Babji *et al*. (2000) and Singh *et al*. (2011) observed lowered yeast and mold counts in vacuum packaged goat meat and chicken snacks, respectively, when compared to aerobically packed samples. However, these counts were well below the permissible limits for cooked meat products (Jay 1996). Coli forms were not detected (ND) throughout the storage study. Das and Jayaraman (2003) had reported absence of coli forms during ambient temperature storage of dehydrated chicken *pulav*.

Sensory qualities: Mean sensory score of products are presented in Table 5. The appearance score was almost comparable up to 30th day of storage and thereafter decreased significantly (P<0.05) on 45th day of storage in the control product. The sensory score of treatment for appearance of dried rings showed a progressive nonsignificant decline (P>0.05) with the increase in storage period. In addition, there was no significant difference (P>0.05) in the appearance score between control and treatment throughout the storage period. A significant decrease in colour of dehydrated chicken *pulav* during storage at ambient temperature and non-significant at chiller temperature was reported by Das and Jayaraman (2003). The sensory scores of control product for appearance of rehydrated and cooked meat rings were almost stable up to 15th day but scores decreased significantly (P<0.05) on 30th day and remained almost constant up to 45th day of storage. Appearance scores for rehydrated and cooked meat rings of treatment were comparable to control during the entire period of storage. Karthikeyan *et al*. (2000) also reported a reduction in colour scores during ambient temperature storage of vacuum packaged hurdle treated caprine *keema* and attributed it to the lipid oxidation and the oxidised compounds reacting with amino acids causing non enzymatic browning. The flavour score was almost comparable up to 30th day of storage and thereafter decreased significantly (P<0.05) on 45th day of storage in the control product. The sensory score for flavour of treated products showed a progressive non-significant decline (P>0.05) with increase in storage period. Flavour score for treatment was comparable to control during the entire period of storage. Kharb *et al*. (2008) reported a non significant decrease in flavour scores for dehydrated spent hen meat mince on ambient temperature storage. The average scores for texture of control and treated products indicated non significant decreasing trend. In addition, there was no significant difference (P>0.05) in the texture score between control and treatment on any particular day of storage. Singh *et al*. (2009) had reported a nonsignificant decrease in the texture scores in snacks containing broiler spent hen meat, rice flour and sodium caesinate. There was a nonsignificant (P>0.05) decrease in meat flavour intensity scores of control products up to 15th day but it declined significantly (P<0.05) on 30th day and remained almost constant up to 45th day of storage. The meat flavor intensity score for treatment was comparable to control during the entire period of storage. Sharma and Nanda (2002) reported a significant decrease in meat flavour intensity during vacuum-packaged storage of chicken chips at ambient temperature. The juiciness score of control product on 45th day was significantly (P<0.05) lower than the initial value but was comparable with the score on 15th and 30th day of storage. The score of juiciness of treated product on 45th day was significantly (P<0.05) lower than the score on 0 and 15th day of storage but was comparable with 30th day of storage. Juiciness score of treatment was significantly (P<0.05) lower than the control on 0 day of storage. This might be probably due to the interaction between meat and rice flour and rehydration of the meat rings. Modi *et al*. (2007) reported that juiciness of chicken *kebabs* prepared from dehydrated mix was affected by the level of starch, milk powder and the interaction between the two. Modi and Prakash (2008) reported that maize flour had the decreasing effect on the juiciness of extended and dehydrated meat cubes, after rehydration. There was nonsignificant (P>0.05) decrease in overall acceptability scores of control and treatment products up to 15th day, but it declined significantly (P<0.05) on 30th day and remained almost constant up to 45th day of storage. Overall acceptability score for treatment was comparable to control during the entire period of storage.

These observations indicated that dehydrated chicken meat rings extended with optimum level of extender i.e 10% rice flour (1:1 hydration, w/w) retained good to very good acceptability when stored in vacuum packaged laminated pouches at ambient temperature (30±2°C) for 45 days without any marked demotion of physico-chemical, microbiological and sensory quality.

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