DR-1870
[1-6]

RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume Issue : ()

Development of Ready to Cook Dehydrated Chicken Cutlet Mix and its Quality Changes During Storage at Ambient Temperature

S. Tomar[1], G. Chauhan[2], A. Das[2], S. Meshram[1]

10.18805/ajdfr.DR-1870

ABSTRACT

Background: The rising preference for convenience food among the new age consumers has led to the development of time saving, shelf stable ready-to-cook food products. Considering this, the aim of the study was to develop a nutritious, convenience and shelf stable Ready to Cook chicken cutlet mix (RTCCCM) and check its storage stability in terms of quality changes at ambient temperature storage for a period of 3 months.

Method: Formulation of RTCCCM was standardized using fermented milk powder as a binder and was extended with dehydrated vegetable mix. The mix after processing was packaged in Aluminium foil- LDPE laminates (ALP) and stored at ambient temperature for 3 months.

Result: RTCCCM was rich in minerals, nutrients and energy. With progression in storage significant ($p<0.05$) increase in PV, TBARS and FFA were recorded while the pH followed a decreasing trend. The a_w of the mix was well within the limits of dehydrated products. The mix was microbiologically stable upto 90 days of storage. Sensory analysis of cutlets prepared from 90 day stored mix was found to be organoleptically acceptable, with no marked changes in flavor and quality suggesting that RTCCCM could be used safely as a convenience product under aerobic conditions with minor losses of physico-chemical properties, colour, textural, microbiological and sensory quality.

Key words: Chicken cutlet, Fermented milk powder, Ready to cook.

INTRODUCTION

In the recent past, there has been a great change in socio-economic scenario of the developing countries, characterized by increased work force and purchasing power. With technological advancement and globalization, the world has shrunken and most people, particularly the youth are residing away from their houses because of their career opportunities. Further, with altered household scenario, females are now earning members of the family and spending a major part of their time at workplaces. Thus, the present situation has imposed a need of time saving characteristics and convenience in all the aspects of life including the food. In this over busy socially networked era with fast-paced city life, increasing number of working couples and internet savvy younger generation prefer food products which are easy to prepare, convenient, handy, time saving and add variety to taste. Ready to cook, shelf stable foods qualify these aspects with easiness in cooking and longer shelf life at room temperature avoiding the need of cold chain for their storage.

Meat cutlets are crunchy, crispy, energy dense traditional meat treats consumed as snacks to satisfy short term hunger. However, bulky and perishable nature of such products limits their role in wide use. Dehydration is an effective way to improve the durability, shelf life besides making them nutrient dense and convenient in terms of storage, handling and transportation due to their smaller volume.

Fermented milk powder (FMP), a rich source of protein with superior nutritional, organoleptic and functional properties, has therapeutic values, increased digestibility, higher calcium, B-vitamins and low lactose. Biochemical changes during fermentation adds the characteristics to lower plasma cholesterol levels and enhance the immune response, mineral solubility and bioavailability (Walter, 1996). Incorporation of FMP may serve to be one of the valuable means to enhance the technological aspects and functionality of meat products.

Studies have been conducted by few authors in development of instant meat based mixes such as dehydrated chicken *kebab* mix Modi *et al.* (2007), instant spent hen based soup mix (Gokul Krishnan, 2014) and dehydrated fish cutlet mix Shavikalo *et al.*(2013). These

[1]Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Rewa-486 001, Madhya Pradesh, India.
[2]Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar, Bareilly-243 122, Uttar Pradesh, India.

Corresponding Author: S. Tomar, Department of Livestock Products Technology, College of Veterinary Science and Animal Husbandry, Rewa-486 001, Madhya Pradesh, India.
Email: serlenelpt@gmail.com

How to cite this article: Tomar, S., Chauhan, G., Das, A. and Meshram, S. (2022). Development of Ready to Cook Dehydrated Chicken Cutlet Mix and its Quality Changes During Storage at Ambient Temperature. Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-1870.

Submitted: 14-01-2022 **Accepted:** 01-06-2022 **Online:** 29-06-2022

products had good sensory acceptability and was stable for a long period of time. However, no work has been conducted on development of cutlet mix which in addition to the basic nutritional value of meat carries the additional benefits of binders such as milk powders and dietry fibres such as dehydrated vegetables. Such mixes could serve multifunctional roles by satisfying consumer preferences, nutritional value, health benefits and most importantly a time saving convenience product for working population and snack lovers. In view of the above facts, this study was conducted to develop a nutritious, convenience and shelf stable Ready to Cook chicken cutlet mix (RTCCCM).

MATERIALS AND METHODS

The experiment was carried out at Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar. Spent hen meat (above 72 weeks) obtained from Central Avian Research Institute, Izatnagar was minced, mixed with sodium tripolyphosphates (0.3 g/100 g raw meat) and pressure cooked (15 psi for 30 min). Fermented milk powder was prepared by inoculating boiled and cooled skim milk with mixed mesophilic starter culture (NCDC-167). Curd was allowed to set at 35-37°C overnight followed by centrifugation to remove the whey, dried and pulverized. The sifted powder was packaged in Aluminium laminated pouches and stored at room temperature upto use. Potatoes were blanched in hot water (75-80°C) followed by soaking in 0.2% $K_2S_2O_5$ solution for 20 minutes, shredded and thereafter dried in food drier for addition in the cutlet mix. Dehydrated vegetable mix (DVM) consisting of french beans, carrots and green peas was prepared for enrichment of RTCCCM. Fresh, clean vegetables were blanched in hot water (75-80°C), chopped into small pieces, dried at 50°C for 8 h in a food drier and packaged till further addition to RTCCCM. Spice mix powder used in the study was prepared by grinding oven dried (60°C for overnight) ingredients *viz*. coriander, cumin seed, aniseed, black pepper, caraway, turmeric, dried ginger, capsicum, cardamom, cinnamon, cloves, nutmeg and mace while condiments such as peeled onions, garlic and ginger were taken in the ratio of 10:2:1 and were made into a fine paste. Other ingredients such as salt and refined wheat flour were purchased from the local market of Bareilly.

An intensive series of trials were conducted to standardize the formulation as given in Table 1 and processing conditions of RTCCCM. The pre-cooked meat mince as per the formulation was mashed well and uniformly blended with other ingredients ie. salt, spice mix, condiments, refined wheat flour, shredded and dried potato, textured soya protein, corn starch, FMP and blended manually. The resultant mix was spread evenly in a tray and thereafter dried in a food drier at 60±1°C for 12 h. DVM was added to the dried mix at the desired concentration and the resultant mix was packaged in aluminium foil-LDPE laminate pouches (ALP) (Al foil 15 µ -LDPE 40 µ), stored at ambient temperature and evaluated at regular intervals of 15 days for proximate composition, physico-chemical, microbiological and sensory quality attributes for a period of 90 days. Proximate analysis of RTCCCM was determined by AOAC (1995) procedures. Total dietary fibre and cholesterol were determined by method of Furda (1981) and Folch et al. 1957. Calcium and phosphorus were determined by AOAC (1995) and microminerals by Atomic Absorption Spectrophotometer. pH, Water activity (a_w), TBARS (Witte *et al*. 1970), Peroxide value (PV) and free fatty acids (FFA) (Koniecko, 1979) were estimated at different storage intervals. Color profile was measured using Hunter Color Lab set at 2° of cool white light. Standard plate count (SPC), coliform, yeast and mould (YMC), staphylococcal count were determined by methods of APHA (2001). Fresh cutlets were prepared from RTCCCM for conduct of sensory evaluations on 8 point descriptive scale where 8= excellent and 1=extremely poor (Keeton, 1983). Data were analyzed statistically on SPSS-16.0 software package as per standard methods (Snedecor, 1994).

RESULTS AND DISCUSSION

Nutritional profile of RTCCCM

Table 1: Basic formulation of RTCCM.

Ingredients	Quantity (%)
Lean meat (minced and cooked)	62.5
Salt	1.75
Spices	2
Condiments	13
Refined wheat flour	3
Textured soya protein	3
Corn starch	3
Blanched and Shredded potato	5
Fermented milk powder	7.5
Dehydrated vegetable mix	5

Table 2: Nutritional profile of RTCCCM (Mean ±SE), n=6.

Parameters	Value
Proximate composition	
Moisture (%)	5.69±0.01
Fat (%)	8.05±0.05
Protein (%)	34.79±0.16
Ash (%)	5.4±0.13
Total dietary fibre (%)	2.11±0.02
Carbohydrate (%)	46.07±0.20
Total energy (kcal/ 100g)	396k cal
Cholesterol (mg/g)	1.87±0.09
Mineral Profile	
Calcium (mg/g)	1.71±0.08
Phosphorus (mg/g)	3.06±0.67
Cobalt (ppm)	32.41±0.21
Zinc (ppm)	18.60±0.34
Iron (ppm)	61.63±0.11
Manganese (ppm)	9.34±0.27
Copper(ppm)	12.12 ±0.25

The results of nutritional and mineral analysis is shown in Table 2. The drying process lowered the moisture content of RTCCCM however, was within the prescribed limit for dehydrated products. Similar results have been reported for extended chicken cubes by Shiby *et al.* (2015), dehydrated extended chicken meat rings Mishra *et al.* (2015) and instant fish soup mix Rahman *et al.* (2012). The mix however, had a high fat and protein content which may be related to the concentration of proximate components during dehydration. Moreover, FMP incorporation could have contributed to increased level of protein. Similar results have been recorded in dehydrated kebab mix Modi *et al. (*2007). The addition of FMP, a rich source of calcium and phosphorus relatively increased the ash content in the mix and similar results have been noticed in dehydrated fish cutlet mix Shaviklo *et al.* (2013). Dietary fibre content of 2.11±0.02% in RTCCCM may be attributed to the addition of DVM, which are high fibre sources. DVM incorporation may also serve certain technological characteristics like water binding, gelling and structure building of the product. Cholesterol content of RTCCCM was in agreement with Mishra *et al*. (2015), who reported a cholesterol content of 2.83 mg/g in dehydrated chicken meat rings.

Addition of FMP (calcium -1.2%) and DVM increased the calcium and phosphorus content of RTCCCM. Minerals such as Zn, Cu, Co, Mn and Fe were lower than those reported by Mishra *et al.* (2015) but higher than fresh chicken meat which may be attributed to the differences in product formulation and considering the fact that no specific meat cut was used.

Physico-chemical parameters

The results are presented in Table 3. The gradual significant decline in pH of RTCCCM during storage might be related to occurrence of chemical changes or growth of carbohydrate fermentable microbes resulting in lactic acid formation. Acidic pH of FMP (pH-4.40) resulted in low pH of the product as compared to other chicken meat products. The results are in accordance with those observed in meat biscuits and *kaddid*, a salted, dried meat product by Kumar *et al.* (2016) and Bennani (2000)

The a_w of RTCCCM during the study period was well within the threshold limits for dried products which usually have a_w below 0.7 (Lewicki, 2004). Increase, observed towards the end of storage might be due to a concomitant increase in moisture content after packaging and during storage. Similar reports have been made by Shiby *et al.* (2015) and Shaviklo *et al.* (2013) in dehydrated chicken meat cubes and instant fish cutlet mix stored at ambient temperature. According to Rahman *et al.*(2012) lowering of water content resulted in lowered a_w, although both these parameters were not directly proportional.

Initial TBARS values were quite high and showed a non-significant increase upto 30 days of storage which further increased significantly with storage time. Volatile compounds formed as a result of oxidation of PUFA led to an increase in TBARS value. Initial high TBARS value observed might be due to precooking of meat, high dry matter content, physical forces involved in preparation process, resulting in extensive destruction of cellular structure, allowing mixing of various meat constituents and pro-oxidants (Rhee, 2004). Similar results have been recorded in freeze dried beef Sun *et al.* (2002) and aerobically packed *pastirma* Goak *et al.* (2008).

FFA increased significantly during storage which might be due to enzymatic/ microbial lipolysis of fat. During the 1st month of storage non-significant increase was recorded however, with time gradual and significant increase were observed. In general, FFA content alone does not act as criteria for acceptability of products but may act as a strong quality indicator for oxidative changes in fat during storage. Similar results have been reported for a number of

Table 3: Changes in quality attributes of Ready to cook dehydrated chicken cutlet mix (RTCCCM) packaged in ALP during storage at ambient temperature (Mean±SE).

Parameters	Day 1	Day 15	Day 30	Day 45	Day 60	Day 75	Day 90
				Physico-chemical characteristics			
pH	6.10±0.02 ^{a}	6.09±0.02^{ab}	6.05±0.03^{abc}	6.03±0.02^{bc}	6.00±0.01 ^{cd}	5.99±0.02 ^{d}	5.95±0.02 ^{d}
Moisture (%)	5.69±0.26	5.71±0.35	5.75±0.24	5.81±0.26	5.87±0.06	5.90±0.04	5.94±0.08
a_w	0.336±0.003^{d}	0.336±0.005^{d}	0.343±0.007^{cd}	0.345±0.003^{bcd}	0.350±0.003^{abc}	0.357±0.002^{ab}	0.360±0.004^{a}
TBARS value(mg MDA/kg)	0.41±0.09^{d}	0.41±0.08^{d}	0.50±0.11^{bd}	0.59±0.10^{bc}	0.65±0.07^{bc}	0.74±0.16^{ab}	0.88±0.14^{a}
FFA value (%)	0.249±0.01 ^{e}	0.274±0.02 ^{e}	0.298±0.02 ^{de}	0.340±0.01 ^{cd}	0.379±0.01^{bc}	0.417±0.02 ^{b}	0.499±0.02 ^{a}
Peroxide value(meq/ kg)	1.78±0.16 ^{c}	1.94±0.12^{bc}	2.15±0.17^{abc}	2.33±0.16^{ab}	2.44±0.09 ^{a}	2.52±0.14 ^{a}	2.57±0.16 ^{a}
				Instrumental color profile			
L	63.14±1.47	63.64±1.22	63.09±0.48	62.74±0.86	61.55±1.05	62.61±1.29	59.55±0.43
a	5.88±0.10	5.88±0.09	5.96±0.12	5.98±0.13	5.99±0.15	6.12±0.13	6.09±0.11
b	16.17±0.12^{ab}	16.05±0.30^{b}	16.25±0.23^{ab}	16.53±0.20^{ab}	16.70±0.19^{ab}	16.82±0.18^{ab}	16.99±0.18^{a}
Hue	70.01±0.39	69.86±0.40	69.83±0.63	70.11±0.37	70.24±0.31	70.05±0.36	70.27±0.25
Chroma	17.22±0.12^{bc}	17.10±0.32^{c}	17.31±0.20^{abc}	17.58±0.22^{abc}	17.74±0.20^{ab}	17.89±0.16^{a}	18.04±0.18^{a}
Color change (ÄE)	0.00±0.00^{b}	3.78±0.97^{a}	3.52±0.78^{a}	3.98±1.15^{a}	4.88±1.14^{a}	4.99±1.40^{a}	4.31±0.72^{a}

Mean±SE with different superscripts in a row differ significantly ($p<0.05$), n=6.

dehydrated products including chicken chunks Hameed *et al.* (2007).

PV gives a measurement of peroxides and hydroperoxides formed initially during lipid oxidation. PV showed 44.55% increase from the initial day to the last day of storage. Significant difference in PV was recorded at the beginning of the study however, with progress in storage non-significant differences were recorded from end of 2nd month upto the end of storage which may be due to decline in production of peroxides during later stages of storage (Yan and White, 1990). Similar increase in PV has been recorded during storage of freezedried goat meat by Rahman *et al.* (2012).

Instrumental color profile

The scores for the instrumental colour profile is represented in Table 3. High *L* value of RTCCCM might be due to the incorporation of FMP that had a predominant white colour. Evidence of higher *L* values and higher spectra curves in cooked chicken meat batters incorporated with skim milk powders and whey proteins has been cited by Barbut (2010). Drying method adopted may have resulted in significant effects on the colour profile of RTCCCM, which reflects the degree of browning during drying as well as being a cause of variation in light scattering from the surface of the meat (Van Oeckel *et al.* 1999). The same would have been the reason for decrease in *L* value with advancement of storage period. A gradual non-significant increase was observed for *a* value, however, was not much perceived due to the white color of FMP. Similar results were observed in dehydrated *kebab* mix by Modi *et al.* (2007) during storage at ambient temperature. Initially, a decrease in *b* value was noted on day 15 which increased thereafter towards end of the storage period. However, this increase was significant only on day 90. Lipid oxidation and non-enzymatic browning, interaction of ingredients (Osuna-Garcia *et al.* 1997), method of processing, packaging and exposure to light (Kim *et al.* 2002) would have influenced color of the product during storage. Hue value followed an non-significantly increasing trend while Chroma values increased significantly towards the end of storage period. The increase in values may be correlated with the increasing *a* and *b* values observed during storage. Similar increase in chroma values have been noted by Mishra *et al.* (2015) in dehydrated chicken meat rings. Colour change *i.e* DE of RTCCCM followed an non-significant increasing pattern during storage. Despite changes in the *a* and *b* values, the DE was notably non-significant, indicating that increased values of *a* and *b* did not much affect the product color acceptability. Similarly, Modi *et al.* (2007) reported that changes in the color of *kebab* mix were quite acceptable even after 6 months of storage at 27±2°C.

Microbiological analysis

The mean values for different microbiological parameters are presented in Table 4. Results in the present study are in agreement with that of Mishra *et al.* (2015) who reported an increase in SPC of dehydrated meat products. It was observed that even after 3 months of storage SPC were well below the permissible limit for dried products (5 log cfu/g) (Jay, 1996) which may be due to thermal processing, low a and antibacterial effects of additives in RTCCCM while post processing contamination may be the reasons for increase in SPC during storage.

A gradual, but non-linear increase was observed in *Staphylococcus aureus* count during storage. The presence of organism in the mix reveals post processing contamination. Modi *et al.* (2007) recorded initial staphylococci counts of 3.3 log cfu/g which markedly decreased by 2 log cycles after 1 month of storage and thereafter increased to 2.0 log cfu/g during storage. Absence of coliforms may be related to the processing conditions of RTCCCM. YMC increased significantly ($p<0.05$) from day 15 till the end of storage period. Marked increase in YMC during storage was reported for various dehydrated meat products such as chicken noodles by Bhaskaran *et al.* (2011).

Sensory evaluation

Critical appraisal of results from Table 5 revealed a non-significant decrease in appearance scores of cutlets with advancement of storage period which might be attributed to the deep fat frying technique which provided a similar appearance to the product. Similar decrease has been noted in *kebabs* prepared from dehydrated mix (Modi *et al.* 2007). Juiciness in rehydrated products may be attributed to the interaction of FMP, DVM, textured soy protein and their rehydration. The cutlets prepared from the mix had appreciable juiciness that decreased non-significantly during the study period. Similarly, decreased juiciness of *kebabs* prepared from dehydrated mix has been reported upon storage at ambient temperature (Modi *et al.* 2007). Flavor scored well upto day 15, thereafter decreased with the changes at various intervals being comparable to day 1 and day 90. The flavour score on day 90 ranged between moderately desirable to very desirable. Decline of flavor could be correlated to increase in TBARS value of meat

Table 4: Changes in microbiological quality (log cfu/g) of RTCCCM packaged in ALP during ambient storage (Mean±SE).

Parameters	Day 1	Day 15	Day 30	Day 45	Day 60	Day 75	Day 90
Standard plate count	1.97±0.11	2.02±0.15	2.19±0.22	2.33±0.27	2.36±0.40	2.46±0.30	2.51±0.38
S. aureus	0.88±0.12^{b}	1.13±0.18^{ab}	1.09±0.23^{ab}	1.24±0.19^{ab}	1.21±0.20^{ab}	1.33±0.19^{ab}	1.51±0.25^{a}
Coliform count	ND	ND	ND	ND	ND	ND	ND
Yeast and mold count	ND	0.82±0.26^{c}	0.87±0.10^{c}	1.108±0.44^{bc}	1.42±0.13^{ab}	1.58±0.21^{a}	1.71±0.22^{a}

Mean±SE with different superscripts in a row differ significantly ($p<0.05$), n=6, ND-not detected.

Table 5: Changes in sensory attributes of chicken cutlets prepared from RTCCCM packaged in ALP during ambient storage(Mean±SE).

Sensory attributes*	Day 1	Day 15	Day 30	Day 45	Day60	Day 75	Day 90
Appearance	6.89±0.14	6.95±0.21	6.92±0.28	6.85±0.21	6.82±0.27	6.80±0.33	6.80±0.41
Juiciness	6.67±0.21	6.75±0.23	0.63±0.18	6.60±0.29	6.60±0.31	6.57±0.28	6.55±0.36
Flavor	6.94±0.15^{a}	7.00±0.22 ^{a}	6.90±0.14^{ab}	6.85±0.24^{ab}	6.83±0.34^{ab}	6.79±0.30^{ab}	6.67±0.29 ^{b}
Meat flavor intensity (MFI)	6.70±0.24	6.75±0.23	6.71±0.29	6.67±0.27	6.64±0.25	6.60±0.33	6.49±0.35
Texture	6.82±0.22 ^{a}	6.75±0.21 ^{a}	6.75±0.26 ^{a}	6.67±0.26^{ab}	6.61±0.26^{ab}	6.59±0.26^{ab}	6.50±0.36 ^{b}
Overall acceptability (OA)	6.83±0.31^{ab}	6.94±0.34 ^{a}	6.81±0.26^{ab}	6.77±0.28^{ab}	6.74±0.32^{ab}	6.70±0.29^{ab}	6.60±0.29 ^{b}

Mean±SE with different superscripts in a row differ significantly ($p<0.05$), n=21.

*Score on 8 point descriptive scale.

products (Witte *et al.*1970) and to the expected loss of volatile flavor components from ingredients during storage period. MFI followed a similar pattern as that of flavor. Modi and Prakash (2008) reported an increase in MFI of meat cubes incorporated with vegetables due to the presence of sulfur and carbonyl compounds. A similar reaction would have resulted in improved flavor and MFI of cutlets.

Texture, declined with increase in storage time, however the decline was significant ($p<0.05$) only on day 90. Modi *et al.* (2007) reported a not signiûcant difference in texture parameters of kebabs from dehydrated mix. With progression in storage non-significant decrease in OA was recorded till 75th day while a significantly lower value was observed on day 90 as compared to day 15. The decrease in OA might be due to biochemical changes brought about by microorganisms and chemical reactions occurring in the product.

CONCLUSION

FMP at 7.5% levels could be used as a suitable binder in RTCCCM with significant improvement in texture and antioxidant potential of the product while extension of RTCCCM with DVM at 5% levels improved the nutritional composition, TDF content, antioxidant effect and sensory acceptability of the product. There was no significant change in sensory and microbiological quality of FMP incorporated RTCCCM during storage of 90 days at ambient temperature. Hence, it can be concluded that RTCCCM was nutritious, safe, highly acceptable product and could serve a time saving alternative for fresh chicken cutlets. Cutlets prepared from the mix can prove to be a valuable snack food item being a source of essential amino acids and other nutrients. The ready to cook mix can be conveniently stored in ALP at ambient temperature for 90 days and more with only minor changes in quality characteristics thereby permitting limitless marketing opportunities.

ACKNOWLEDGEMET

The authors would like to acknowledge ICAR-IVRI, Izatnagar, U.P., India for providing funds and facilities to carry out this research work.

Conflict of interest: None.

REFERENCES

AOAC. (1995). Official Methods of Analysis. 16th ed. Rockville, MD, USA: AOAC.

APHA. (2001). Compendium of Methods of Microbiological Examination of Foods. 4th ed. Washington, DC, USA.

Barbut, S. (2010). Effects of milk powder and its components on texture, yield and color of a lean poultry meat model system. Poultry Science. 89(6): 1320-1324.

Bennani, L., Faid, M., Bouseta, A. (2000). Experimental manufacturing of kaddid, a salted dried meat product. European Food Research Technology. 211: 153-157.

Bhaskaran, D., MuthuPandian, K, Gnanalakshm,, K.S., Ayyadurai, K,.Jothylingam, S. (2011). Effect of addition of whey protein concentrate and skim milk powder on chemical and microbiological characteristics of noodles. Journal of Current Science. 16(1): 255-260.

Folch, J., Less, M., Saloane-stanley, G.H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry. 226: 497-509.

Furda, I. (1981). Simultaneous Analysis of Soluble and Insoluble Dietry Fiber. In the Analysis of Dietry Fiber in Foods ed. by W.P.T James and O. Theander. Marcel Dekker. pp. 163-172.

Gök, V., Obuz, E., Akkaya, L. (2008). Effects of packaging method and storage time on the chemical, microbiological and sensory properties of Turkish pastirma-A dry cured beef product. Meat Science. 80(2): 335-344.

Gokulkrishnan, P. (2014). Development and quality evaluation of spent hen meat powder and its utilization in convenience meat products. PhD thesis submitted to Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P.

Hameed, R.S., Kanchana, S., Vennila, P., Hemalatha, G. (2007). Storage stability of dehydrated chicken chunks in different packaging materials. Indian Veterinary Journal. 84: 1283-1285.

Jay, J.M. (1996). In: Modern Food Microbiology 4th edn.pp. 38-39. Keeton, J.T. (1983) Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. Journal of Food Science. 48: 878-881.

Kim, E.H.J., Chen, X.D., Pearce, D.(2002) Surface characterization of four industrial spray-dried dairy powders in relation to chemical composition, structure and wetting property. Colloid Surface. 26(3): 197-212.

Koniecko, E.K. (1979). Handbook for Meat Chemists. Wayne, NJ, USA.

Kumar, P., Chatli, M.K., Mehta, N., Malav, O.P., Verma, A.K., Kumar, D. (2016). Quality attributes and storage stability of chicken meat biscuits incorporated with wheat and oat bran. Journal of Food Quality. 39(6): 649-657.

Lewicki, P.P. (2004) Drying. In: Encyclopaedia of Meat Sciences, Vol-1. Elsevier Ltd. pp. 402-411.

Mishra, B.P., Chauhan, G., Mendiratta, S.K., Sharma, B.D., Desai, B.A., Rath, P.K. (2015). Development and quality evaluation of dehydrated chicken meat rings using spent hen meat and different extenders. Journal of Food Science Technology. 52(4): 2121-2129.

Modi, V.K., Prakash, M. (2008). Quick and reliable screening of compatible ingredients for the formulation of extended meat cubes using Plackett-Burman design. LWT-Food Science Technology. 41(5): 878-882.

Modi, V.K., Sachindra, N.M., Nagegowda, P., Mahendrakar, N.S., Rao, D.N. (2007). Quality changes during the storage of dehydrated chicken kebab mix. International Journal Food Science and Technology. 42: 827-835.

Osuna Garcia, J.A., Wall, M.M, Waddell, C.A. (1997). Natural antioxidants for preventing color loss in stored paprika. Journal of Food Science. 62(5):1017-1021.

Rahman, M.A., Saifullah, M., Islam, M.N. (2012). Fish powder in instant fish soup mix. Journal of Bangladesh Agricultural University. 10(1): 145-148.

Rhee, K.S., Myers, C.E. (2004). Sensory properties and lipid oxidation in aerobically refrigerated cooked ground goat meat. Meat Science. 66(1): 189-194.

Shaviklo, G.R., Thorkelsson, G., Sveinsdottir, K., Pourreza, F. (2013). Studies on processing, consumer survey and storage stability of a ready-to-reconstitute fish cutlet mix. Journal of Food Science and Technology. 50(5): 900-908.

Shiby, V., Tabassum, A., George, J., Pandey, M., Radhakrishna, K. (2015). Effect of drying methods on moisture sorption, microstructure and other quality characteristics of chicken cubes. International Journal of Advanced Research. 3(12): 1200-1213

Snedecor, G.W. and Cochran, W.G. (1994). Statistical Methods, 8th edn, Lowa State University Press, Iowa.

Sun, Q., Senecal, A., Chinachoti, P., Faustman, C. (2002). Effect of Water Activity on Lipid Oxidation and Protein Solubility in Freeze dried Beef during Storage. Journal of Food Science. 67(7): 2512-2516.

Van Oeckel, M.J., Warnants, N., Boucqué, C.V. (1999). Measurement and prediction of pork colour1. Meat Science. 52(4): 347-354.

Walter, S. (1996). Yoghurt powder as a ûavour and functional ingredient, in Food Ingredients" Europe. Conference Proceedings, 12-14 November, Porte de Versailles, Paris, Washington.pp 73-75.

Witte, V.C., Krause, G.F., Bailey, M.E. (1970). A new extraction method for determining Thiobarbituric acid values of pork beef during storage.Journal of Food Science. 35: 582-585.