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ORIGINAL ARTICLE

Quality of fried broiler chicken leg muscles stored at different temperatures

Pandey M. C. · Manral Mallika · Srihari K. A. · Jayathilakan K. · Radhakrishna K. · Bawa A. S.

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Abstract Chicken leg pieces (60 g each). with optimized quantity of additives were fried in hydrogenated vegetable oil at 180°C for 8 min. The fried product was packed in paper-foil-polyethylene pouches (PFP) and stored under ambient (20 ± 5°C, 65–80% RH), refrigerator (5°C, 80% RH) and deep freezer (–18°C, 85–90% RH) conditions. The changes in microbial profile, oxidative and hydrolytic rancidity and sensory quality were evaluated periodically. It was found that the product was microbiologically (standard plate count (SPC) < 3 log cfu/g) safe and sensorily acceptable (overall acceptability >7) up to 4 days under ambient conditions. Hydrolytic and oxidative rancidity values during four days storage at room temperature were less than 0.16 % oleic acid and 3.5 mg malonaldehyde/kg, respectively. The products stored under refrigerated and deep freezer exhibited a shelf stability of 10 and 18 weeks, respectively. SPC was 1.3 log cfu/g while rancidity parameters were free fatty acid < 0.43% oleic acid and thiobarbituric acid reactive substances were <6.13 mg malonaldehyde/kg. Sensorily the product exhibited an overall acceptability score of >7 on a 9-point Hedonic scale during refrigerated and frozen storage.

Keywords Chicken · Frying · Microbiological profile · Rancidity · Sensory quality

Pandey M. C. · Manral M. · Srihari K. A. · Jayathilakan K. · Radhakrishna K. · Bawa A. S.
Department of Freeze Drying and Animal Products Technology, Defence Food Research Laboratory, Siddarthanagar, Mysore - 570011, India

Pandey M. C. (✉)
E-mail: dfrlmysore@sancharnet.in

Introduction

Results on microbiological counts as well as physico-chemical and sensory properties of gizzards showed that, they could be stored for 7 days under ambient conditions (15–21°C, 69–82% RH) and 14 days under refrigerated (4 ± 1°C, 80% RH) without affecting quality of the product (Pangas et al. 1998). Anand et al. (1991) found the shelf life of chicken patties stored at –18°C to be 150 days with aerobic counts within acceptable limits. Chang and Chen (1998) prepared chicken hot drumette and found that during refrigerated storage the loss of hotness increased leading to an increase in Thiobarbituric acid values of the products. However, addition of antioxidants retarded the loss of hotness in the products. Mielnik et al. (2002) found that levels of moisture and fat in mechanically deboned poultry meat sausages were mainly affected by carcass part, poultry species and storage time. Milo-Ohr (1999) reported the use of spices, smoking, acidulants and antioxidants to improve the flavour and shelf-life. There is a need to develop and evaluate the shelf-life of stored meat based products, which can fulfill the requirements of the consumers. Considering the above fact, this work was undertaken to develop a ready-to-eat fried chicken product and evaluate its quality during storage under different conditions.

Materials and methods

Fresh 8 weeks old 'White leghorn' (*Gallus domesticus*) broiler chicken (1.5–2 kg) leg portions were procured from local market and cut into 60 g pieces (2.5–3 cm size). The pieces were thoroughly washed under running water and the surface fat was removed. Sunflower refined oil was also procured from the local market. Mini master fryer (M/s Continental, Bangalore) with thermostatic control (6 l capacity) was used for frying the chicken pieces.

Sterilization of spices: Spices procured from the market were subjected to sterilization using autoclave at 121°C

for 15 min to make them free from microorganisms. These sterilized spices were used for the marination of chicken pieces before frying. Microbiological status of spices before and after sterilization was assessed.

Processing of chicken pieces: The chicken pieces were tenderized by immersing them in water containing 6% salt and 0.5% citric acid for 2 h. Before immersing, small cuts were made in chicken flesh pieces manually using a knife so that salt and citric acid penetration could be faster. After 2 h of soaking, water was completely drained off.

Sterilized spices/additives like turmeric (2 g/kg), chilli powder (7 g/kg), chicken *masala* (7 g/kg) and cornstarch (25 g/kg) were added to the chicken pieces and marinated for 30 min. Tertiarybutylhydroxyquinone (TBHQ), an antioxidant, (0.02 mg/100 g) was also incorporated keeping in view the quantity already added in oil and oil absorption in chicken pieces. Frying of chicken pieces was carried out in oil (1:10 product to oil ratio) in a thermostatically controlled fryer at 180°C for 8 min. A stirrer was used to maintain constant temperature of the oil in the fryer. After frying, the excess surface oil was removed by keeping samples on tissue paper. Paper foiled polyethylene (PFP) pouches of size 30 × 20 cm were made from the rolls by sealing on 3 sides and the inner side of the packets were thoroughly cleaned with alcohol. PFP pouches with samples were sealed and kept under 3 storage conditions and evaluated periodically.

Storage evaluation: Three storage conditions i.e., ambient (15–25°C, 65–80% RH), refrigerator (5°C, 80% RH) and deep freezer (–18°C, 85–90% RH) were chosen for storage of the fried product. Microbiological, chemical and sensory profiles initially and during storage were determined on daily, weekly and fortnightly basis for the samples stored under ambient, 5°C and –18°C conditions, respectively. All the evaluations were conducted in triplicate.

Sample treatment for microbiological analysis: Ten g of chicken legs were aseptically cut into small pieces and macerated using a sterile glass pestle and mortar using 90 ml of 0.1% peptone water followed by decimal dilutions using the same diluent. All analyses were performed using media and methods described by Harrigan and McCance (1976). Bacteriological media were obtained from Himedia, Mumbai, India. Enumeration of mesophilic aerobic bacteria (plate count agar 30°C, 48 h), coliforms (Violet red bile agar 37°C, 18 h), spores (heated at 80°C, 15 min Dextrose Tryptone Agar, DIFCO (1984) and incubation at 37°C, 48 h), yeast and molds (acidified Potato Dextrose Agar, incubated at 30°C, 3–5 days), *E.coli*.(PTG agar, 37°C, 18 h Damare et al. 1985) under UV at 366 nm for blue fluorescent colonies), *Staphylococcus cereus* and *Bacillus cereus* (Baird Parker agar and Mannitol egg yolk Polymyxin agar 37°C, 24–48 h), was done. Samples (25 g) were transferred to 200 ml Lactose broth and incubated at 37°C for 24 h for isolation and identification of *Salmonella*.

Chemical analysis: Proximate composition of the chicken pieces after frying was conducted using AOAC (1995) procedures. Thiobarbituric acid reactive substances (TBARS) values expressed as malonaldehyde content were estimated colorimetrically on reaction with 2-thio barbituric acid as per the procedure of Taraldgis et al. (1960). The colorimetric estimation was carried out using Chemito UV visible spectrophotometer (Model 160, Chemito instruments, India). Hydrolytic rancidity expressed in terms of free fatty acids was estimated by the procedure of AOCS (1972) and expressed as percentage of oleic acid.

Sensory evaluation: Sensory evaluation of the fried product was carried out using a 9-point Hedonic scale as per Murray et al. (2001). The product was served hot after refrying for 2 min at 160°C/microwave heating for 2 min. The data relating to texture, aroma, taste and overall acceptability were obtained from a panel consisting of 14 semi trained panelists. Grading varied from, like extremely (9) to dislike extremely (1).

Statistical analysis: Data obtained from chemical (in triplicate) and sensory characteristics (14 panelists) of the product during storage were subjected for ANOVA and comparison of means test was done by Duncan's multiple range test using Costat software (Coplot 2003).

Results and discussion

Microbiological profile: Chicken *masala*, chilli powder and turmeric powder had SPC> 6 log cfu/g, coliforms > 4 log cfu/g, yeast and molds > 3 log cfu/g and spores > 5 log cfu/g before sterilization while all these microbial counts were nil after sterilization (Table 1). Similar observations have been reported by Saraza-Linares et al. (1993).

Washing and soaking of fresh chicken pieces marginally reduced microbial counts (Table 2). Non-sterile composite spices/ additives (had microbial counts (log cfu/g) of 6.4 SPC, 4.6 coliforms, 5.5 yeast and molds and 5.3 spores while sterile composite had only 2 log cfu/g SPC and others could not be detected. As expected chicken smeared with sterile spices had lower counts than those smeared with non-sterile spice/additive (Table 2). Smith et al. (1990) recommended Hazard Analysis Critical Control Point analysis at each stage of processing and distribution of prepared products.

The samples mixed with non-sterile spices/additives under ambient conditions could not stay even one day due to fast microbial growth in the product. Thus, further study was performed with sterile spices/additives. Until 4 days the sample mixed with sterile spices/ additives had SPC less

Table 1 Microbial counts (log cfu/g) of spices before sterilization

	SPC	Coliforms	Yeast and moulds	Spores
Chicken *masala*	6.1	4.0	4.4	5.0
Chilli powder	6.6	4.9	3.4	5.0
Turmeric powder	6.3	4.8	3.6	5.3

The counts were nil after sterilization

Table 2 Microbial counts (log cfu/g) of chicken pieces at each stage of processing

	SPC	Coliforms	Yeast and molds
Chicken fresh	5.5	3.4	3.0
Washed chicken	5.1	3.4	3.0
Chicken after soaking	5.1	3.3	2.5
Chicken smeared with non-sterile spices/additives	4.5	2.5	3.2
Chicken smeared with sterile pieces/ additives	3.8	2.5	3.0

TBARS values were not significantly different ($p>0.05$). The increase in FFA could be attributed to the hydrolysis of triglycerides triggered by the moisture from the food and due to oxidation (Fritsch 1981).

FFA values for refrigerator stored samples indicated that the data did not vary significantly ($p>0.05$) during the storage period of 1–2 and 10–11 weeks while for deep freezer stored samples it did not vary during the period from 0–2 and 8–10 weeks (Fig. 1). The TBARS data for refrigerator stored samples did not vary significantly ($p>0.05$) during 1–2 and 5–6 weeks while for deep freezer stored samples the data for 0–4, 8–10, 10–12 and 16–18 weeks were not significantly ($p>0.05$) different(Fig. 1).

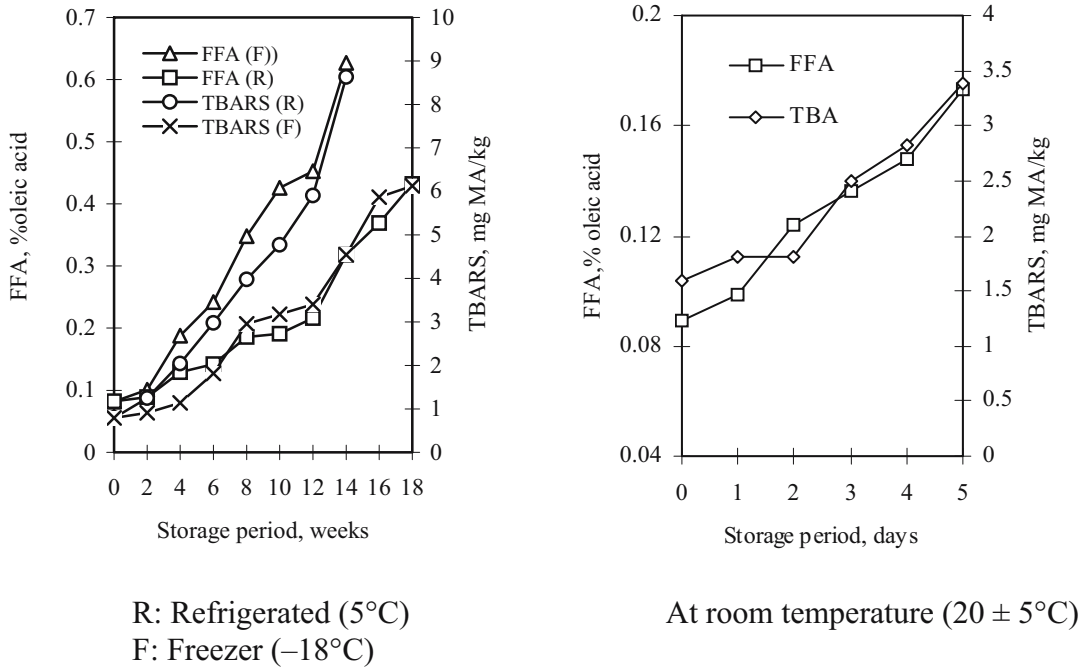

Fig. 1 Changes in free fatty acid (FFA) and thiobarbituric acid reacting substances (TBARS) in fried chicken during storage (n=3)

than 3 log cfu/g, while other parameters were nil but even on 5th day the SPC load was 3 log cfu/g. On 5th day yeast and molds growth was also observed and found to be 1 log cfu/g. The SPC in fried chicken samples were 1–2 log cfu/g and less than 1 log cfu/g when stored at 5°C for 12 weeks and at –18°C for 18 weeks. Coliforms, *E. coli*, spores, *S. aureus*, *Salmonella* and *B.cereus* could not be detected in ambient, refrigerated and frozen storage conditions. Rajkumar et al. (2004) also reported similar results under refrigerated and deep freezer storage conditions

Chemical parameters: The moisture, protein, fat and ash contents of fried chicken leg pieces were found to be 38.5, 35.2, 18.5, and 6.8%, respectively. Chemical analysis, hydrolytic and oxidative rancidity were also evaluated. Free fatty acids (FFA) varied from 0.089 to 0.173 % as oleic acid while TBARS values varied from 1.59 to 3.39 mg malonaldehyde/kg to 5 days of storage at ambient conditions (Fig. 1). For the first and second day of storage, the

Sensory analysis: At ambient conditions, overall acceptability scores did not differ significantly on 0 and 1, 2 and 3 and 3 and 4th day of storage, however it differed significantly ($p<0.05$) on the 5th day of storage. The product was acceptable with sensory score more than 7 (Fig. 2). The overall quality scores for refrigerated storage for 4–6 weeks and 8–10 weeks did not differ significantly ($p>0.05$) as shown in Fig 2. Similarly 0–4, 2–6, 6–8, 8–10, 10–16, 12–18 and 18–20 were also not significantly ($p>0.05$) different. Sensorily the product was acceptable up to 10 weeks and 18 weeks at refrigerated and deep freeze storage temperature, respectively as indicated by scores above 7.0.

Conclusion

Frying at 180°C for 8 min resulted in a good quality fried chicken product which could be stored for 4 days, 10 weeks and 18 weeks under ambient, refrigerated and deep freezer

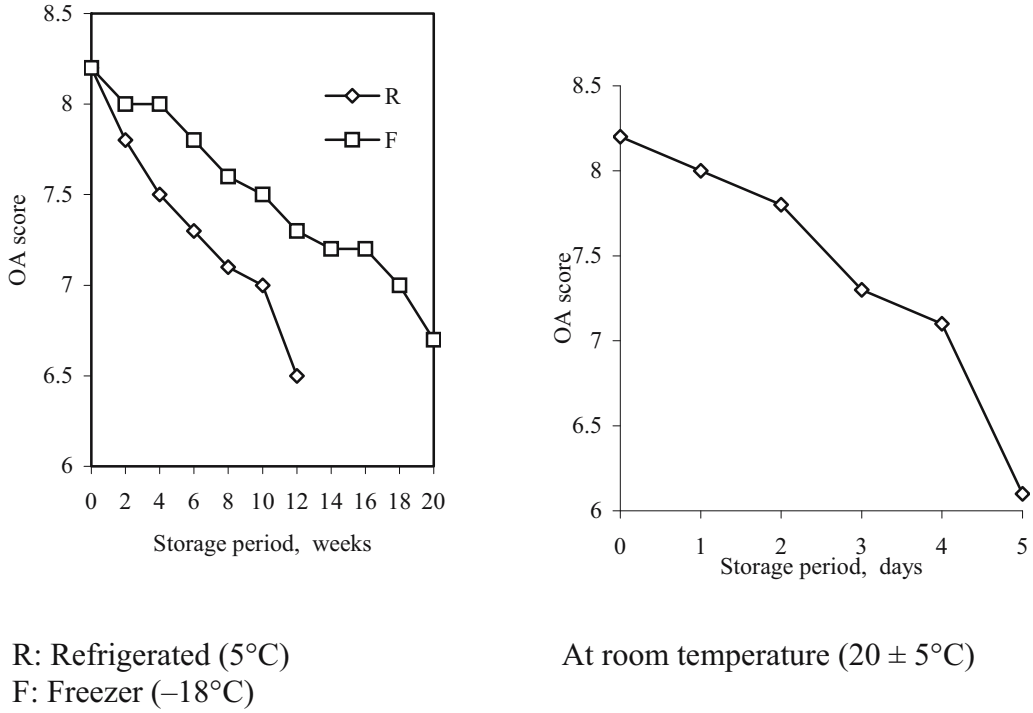

Fig. 2 Changes in sensory overall acceptability scores of chicken during storage (n=14 panelists), OA score: Overall acceptability score

conditions, respectively. Study revealed that the sterilization of the spices prior to processing is one of the crucial steps to reduce the microbial load, leading to enhanced shelf stability of the products. The product was found to be free from pathogens during storage.

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