Efficacy of leaves (*drumstick*, mint and *curry* leaves) powder as natural preservatives in restructured chicken block

A. P. Najeeb · P. K. Mandal · U. K. Pal

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Abstract The use of natural preservatives to increase the shelf-life of meat products is promising as they possess anti-oxidant and antimicrobial properties. Earlier, a highly acceptable restructured chicken slice without the addition of extra fat was developed in the same laboratory which was acceptable up to 10th day of storage under refrigeration and spoilage was mainly due to oxidation. Hence, the present study was planned to determine the efficacy of certain plant leaves' (*drumstick*, mint and *curry* leaves) powder at 1 % level as natural preservatives to enhance the shelf life of restructured chicken slices under refrigerated storage. The quality attributes of the products containing different natural preservatives were compared with the control and reference products. The control product contained no preservative and the reference product contained BHT (200 ppm) only. Incorporation of the leaf powders at 1 % level did not show any significant differences for both cooking yield (99.5–99.6 %) and proximate composition (moisture 72.2–72.3 %, protein 19.2–19.4 %, fat 4.2–4.3 % and total ash 2.3–2.4 %) of the restructured chicken slices compared to both control and reference products during storage. All products containing leaf powders showed significantly ($P<0.01$) lower microbial counts (2.9–3.7 log₁₀ CFU/g) compared to both control and BHT added products. Yeast and mould were not detected in any of the products throughout the storage period. Sensory evaluation scores showed that the restructured chicken slices incorporated with the leaf powders were as acceptable as the reference product and rated good to very good for appearance, flavor, juiciness and overall acceptability. Restructured chicken slices with the leaf powders could be

safely stored without much loss in quality up to 20 days under refrigeration.

Keywords Leaves powder · Natural preservative · Restructured chicken block · Refrigerated storage · Sensory quality

Introduction

Poultry meat industry is witnessing the highest growth rate of 15 % per annum contributing 25 % of the total meat produced in India and accounts for INR four hundred billion to the national GDP (GOI 2010). The strategies for producing healthier meat and meat products involve modification both at the farm level and meat product processing level. Different reformulation strategies are being applied to make meat a functional food, modifying its lipid and fatty acid content, and/or by incorporating a series of functional ingredients like fiber, vegetable proteins, phytochemicals, prebiotics and other natural antioxidants (Fernandez et al. 2004). Utilization of natural preservatives offers adequate microbial safety, replaces the toxic effect of chemical preservatives and has a health promoting effect, thus making the food functional. Considering the necessity of extending the storage stability of poultry meat products, various additives with antioxidant and antibacterial properties have been worked upon, however, with varying degrees of success. The synthetic compounds with antioxidant properties like butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) etc. are not encouraging in meat and allied industry due to their toxic potential and carcinogenic effect (Jayaprakasha et al. 2003).

With national and international barriers regarding the use of chemical food additives in food processing and preservation, search for biological and plant origin food additives have notably increased for the production of high-quality, ready-

A. P. Najeeb · P. K. Mandal (✉) · U. K. Pal
Department of Livestock Products Technology, Rajiv Gandhi
Institute of Veterinary Education and Research, Kurumbapet,
Puducherry 605 009, India
e-mail: mandalpk@gmail.com

to-cook or ready-to-eat products in the recent years (Hazra et al. 2011). In traditional Indian preparations, certain leaves and fruits are added to meat as flavour enhancers either in raw, chopped or ground (as a paste) forms along with other spices. Consumers' interest in meat products formulated with natural preservatives has motivated researchers to evaluate the effectiveness of naturally occurring compounds in plants for functional purposes. Researches on natural preservatives are thus the current trend in meat processing industry.

Different processing combinations with technological advantages have been used in the restructured meat products' preparation to obtain sensory characteristics between that of ground meat and intact muscle steaks. A highly acceptable restructured chicken slice without the addition of extra fat was developed as a novel meat product (Mandal et al. 2002) in this laboratory. The same product was modified by incorporation of chicken gizzard (Mandal et al. 2011). Both the products were found to be organoleptically acceptable only up to 10th day of storage under refrigeration and the deterioration in the quality was found to be mainly due to oxidation with slight increase in the microbial counts. Hence, the present study was planned to determine the efficacy of certain plant leaves (*drumstick*, mint and *curry* leaves) powder as natural preservatives in extending the shelf life of this restructured chicken slice by finding their effects on the physico-chemical, microbiological and sensory attributes of the product.

Materials and methods

Preparation of restructured chicken block Heavy weight broiler chickens were selectively bought from the local market of Puducherry and slaughtered under hygienic conditions in the poultry dressing unit in the Department of Livestock Products Technology, Rajiv Gandhi Institute of Veterinary Education and Research (RIVER), Pondicherry, India. All the carcasses were deboned manually and cut into small chunks and stored in freezer (-18 ± 1 °C) for further use. The standardized recipe for the preparation of restructured chicken slice includes deboned meat (100 %), salt 2 %, sugar 1 %, phosphates 0.4 %, nitrite 150 ppm and water 10 % on meat weight basis (Mandal et al. 2002). The frozen deboned meat was thawed in a refrigerator (7 ± 1 °C) overnight. It was then minced using 8 mm plate in a meat mincer (Mado Shop Mincer Junior, Germany). The minced meat was mixed manually with curing ingredients viz., salt, sugar, phosphate, nitrite and water, as per the recipe and tumbled in a home mixer grinder (Sumeet Machines Ltd, Mumbai, India). The tumbled mass was filled into clean stainless steel moulds lined with food grade aluminium foil, covered with stainless steel lids and placed in refrigerator (7 ± 1 °C) overnight for the curing reaction to occur. Further, cooking was carried out at 90 °C by placing the moulds in water for 45 min. This was followed by

cooling under tap water and chilling overnight (7 ± 1 °C) for setting. The moulds were then removed from the refrigerator to obtain the restructured chicken block. The products were sliced to 3 mm thickness using a meat slicer (Sirmon SPA, Italy).

Preparation and incorporation of leaves powder in restructured chicken block Three different leaves viz, *drumstick*, mint and *curry* leaves were selected for the experiment and preliminary trials were conducted separately to select the mode of use, such as paste, crude extract and powder, at different levels for incorporation in the recipe of restructured chicken block. Based on the effects on sensory and physico-chemical parameters in the preliminary trials, powder form of leaves at 1.0 % level was selected for the actual experiment.

Fresh leaves were purchased from the local market at Puducherry. Leaves were thoroughly washed under running tap water to remove extraneous matter, dried under shade for 8 h followed by final drying in hot air oven at 50 °C for 2 h. The dried leaves were ground in a home mixer grinder and sieved through a fine mesh. The powdered leaves were stored in glass bottles in freezer for further use.

Powders of all three leaves at 1.0 % level were incorporated separately in the standard recipe for the preparation of the restructured chicken block. A reference product was prepared incorporating BHT at the level of 200 ppm and similarly, a control product was made without BHT and leaf powders. After preparation, the test, control and reference products were packed in low density polyethylene (LDPE) bags (200 gauge) and stored under refrigeration (7 ± 1 °C). Samples were drawn on 1, 6, 10, 14, 17 and 20th day of storage to assess the changes in physicochemical, organoleptic and microbiological qualities.

Cooking yield The cooking yield of the product was determined in accordance with the standard procedure carried out by Murphy et al. (1975) and expressed in percentage. The weight of restructured meat blocks were recorded before and after cooking. The cooking yield was calculated and expressed in percentage.

Microbiological quality Microbiological parameters viz, standard plate count and yeast and mould counts were determined by following the procedures recommended by APHA (1984).

Sensory evaluation A semi-trained panel (10) consisting of faculty and postgraduate students of RIVER was used for the sensory evaluation of the product. The nature of the experiment was explained to the panelists without disclosing the identity of samples. They were requested to record their preferences on an 8 point hedonic scale (8=excellent, 1=

Table 1 Effect of different leaf powders on the cooking yield of restructured chicken slices (Mean $\pm$ SD)

Treatments	Cooking yield (%)
Control	99.8 $\pm$ 0.06
Reference	99.7 $\pm$ 0.14
Drumstick leaf	99.5 $\pm$ 0.29
Mint leaf	99.7 $\pm$ 0.19
Curry leaf	99.6 $\pm$ 0.21

extremely poor) for appearance, flavour, juiciness, texture and overall acceptability of the products.

Statistical analysis Each experiment was replicated thrice and each parameter was analyzed in duplicate. The data recorded was analyzed using SPSS version 17.0 (SPSS, Chicago, Ill). One-way analysis of variance (ANOVA) was used for cooking yield and two-way analysis of variance was applied for all the other parameters, followed by tabulation of data. The level of significance were tested by comparing mean values using the least significant difference (LSD) test at 1 and 5 % levels (Snedecor and Cochran 1967).

Results and discussion

Cooking yield of the restructured chicken slices recorded in the present study ranged from 99.46 to 99.80 % and no significant differences were observed among the treatments, control and reference samples (Table 1). Similar to the finding of the present study, Hazra et al. (2011) and Das et al. (2011) reported that addition of *curry* leaf powder (0.2 %) and crude extract of *drumstick* leaves (1 %) in raw ground goat meat patties and cooked ground buffalo meat, respectively did not show any significant ($P<0.05$) differences in the cooking yield compared to the control product. In our earlier experiments the yield of the restructured chicken products (without any preservative) was 100.6 % (Mandal et al. 2002) and 95.5–97.8 % (Sudheer et al. 2011).

Standard plate counts (SPC) of restructured chicken slices varied significantly ($P\leq 0.01$) among the groups and between the days of storage (Table 2). All the products with leaf powders showed significantly ($P\leq 0.01$) lower microbial counts compared to both control and reference products. This indicated that all the leaf powders used in the present study exhibited significant ($P\leq 0.01$) antimicrobial property even after cooking. The lowest SPC values (2.9–3.7 $\log_{10}$ CFU/g) were recorded for *curry* leaf added products followed by *drumstick* (3.1–3.7 $\log_{10}$ CFU/g) and mint leaf (3.1–3.9 $\log_{10}$ CFU/g) treated products throughout the storage period indicating comparatively higher antimicrobial activity of *curry* leaf powder than *drumstick* or mint leaf powders. Earlier we have reported a shelf life of only 10 days for a similar restructured chicken block incorporated with chicken gizzard without any preservative (Sudheer et al. 2011). Antibacterial properties of *drumstick*, mint and *curry* leaves have been reported by various researchers (Chakraborty et al. 1978; Caceres et al. 1991; Ito et al. 1993; Baker et al. 2007; Ningappa et al. 2008; Rahman et al. 2009; Das et al. 2011; Habiba et al. 2011; Hazra et al. 2011; Naseem et al. 2011). Similar to our findings, Hazra et al. (2011) reported that the total plate counts of ground buffalo meat were lowered significantly ($P<0.01$) by the incorporation of *drumstick* leaf extract at different levels (1, 1.5 and 2 %). However, Das et al. (2011) and Biswas et al. (2006) reported that the addition of *curry* leaf powder (0.2 %) did not show any significant antimicrobial effect in goat meat patties, fresh and cooked chicken meat, respectively during refrigerated storage. This might be due to the low level of *curry* leaf powder (0.2 %) used in their study.

Yeast and mould counts were not detected in both test and control products throughout the storage period, which is in accordance with the findings of Sudheer et al. (2011) in restructured chicken slices incorporated with gizzard.

The appearance scores of the restructured chicken slices incorporated with leaf powders and BHT were not affected significantly even up to 20 days of storage under refrigeration and the scores remained above six indicating that all the products were well acceptable (Table 3). For reference

Table 2 Effect of different leaf powders on the SPC values ($\log_{10}$ CFU/g) of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Control	Reference	Drumstick leaf	Mint	Curry leaf
1	3.4 $\pm$ 0.07 ^{bA}	3.4 $\pm$ 0.06 ^{bA}	3.1 $\pm$ 0.12 ^{aA}	3.1 $\pm$ 0.10 ^{aA}	2.9 $\pm$ 0.07 ^{aA}
6	3.5 $\pm$ 0.04 ^{bA}	3.5 $\pm$ 0.05 ^{bB}	3.2 $\pm$ 0.14 ^{aAB}	3.2 $\pm$ 0.06 ^{aB}	3.1 $\pm$ 0.15 ^{aAB}
10	3.8 $\pm$ 0.04 ^{cB}	3.8 $\pm$ 0.07 ^{cC}	3.3 $\pm$ 0.03 ^{abB}	3.4 $\pm$ 0.06 ^{bC}	3.2 $\pm$ 0.07 ^{aB}
14	3.9 $\pm$ 0.04 ^{cBC}	3.9 $\pm$ 0.04 ^{cD}	3.5 $\pm$ 0.08 ^{abC}	3.5 $\pm$ 0.02 ^{bD}	3.3 $\pm$ 0.07 ^{aC}
17	4.1 $\pm$ 0.09 ^{cD}	4.0 $\pm$ 0.05 ^{cD}	3.6 $\pm$ 0.04 ^{abD}	3.7 $\pm$ 0.04 ^{bE}	3.4 $\pm$ 0.02 ^{aC}
20	4.2 $\pm$ 0.17 ^{cD}	4.2 $\pm$ 0.10 ^{cE}	3.7 $\pm$ 0.04 ^{abD}	3.9 $\pm$ 0.04 ^{bF}	3.7 $\pm$ 0.04 ^{aD}

Means with different superscripts (capital letters in the same column and small letters in the same row) differ significantly ($P<0.01$)

Table 3 Effect of different leaf powders on the appearance scores of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Reference	Drumstick leaf	Mint leaf	Curry leaf
1	7.4 $\pm$ 0.64	7.2 $\pm$ 0.76	7.3 $\pm$ 0.62	7.2 $\pm$ 0.72
6	7.3 $\pm$ 0.63	7.1 $\pm$ 0.79	7.2 $\pm$ 0.72	7.1 $\pm$ 0.76
10	7.1 $\pm$ 0.94	7.0 $\pm$ 0.78	7.2 $\pm$ 0.86	7.1 $\pm$ 0.71
14	7.1 $\pm$ 0.92	6.9 $\pm$ 0.92	7.1 $\pm$ 0.85	7.0 $\pm$ 1.02
17	7.0 $\pm$ 0.75	6.8 $\pm$ 0.76	7.1 $\pm$ 0.92	6.9 $\pm$ 0.85
20	7.0 $\pm$ 0.75	6.8 $\pm$ 0.83	7.0 $\pm$ 0.88	6.9 $\pm$ 0.77

products, appearance scores ranged from 7.0 to 7.4 indicating very good, while that of *drumstick* leaf ranged from 6.8 to 7.2 indicating good to very good as per the description in the hedonic scale. These scores were found to be much higher than the appearance scores of similar products (6.3 and 6.3 on 10th day) without any preservative which found to be acceptable up to 10 days (Mandal et al. 2002; Mandal et al. 2011). Slightly higher scores for the BHT added products were probably due to the attractive pink colour of the cured chicken meat compared to the greenish colour of the leaf powder treated products which were comparatively less preferred by the panelists. Similar to our observations, Das et al. (2011) reported that no significant differences were observed in the appearance (colour) scores of goat meat patties added with *curry* leaves powder (0.2 %) and the control products. Biswas et al. (2012) also reported that raw ground pork meat containing mint and *curry* leaf extracts exhibited better colour stability as compared to those treated with sodium nitrite.

Sensory scores for flavour ranged from 6.6 to 7.4 for all the groups, wherein slightly higher scores were recorded for mint leaf (7.2–7.4) and lower scores for *drumstick* leaf (6.58–6.83) treated products indicating good to very good flavour of the products (Table 4). But there were no significant differences among the treatments throughout the storage period. Slightly higher scores for mint leaf added products might be due to the pleasant flavour of mint. On 20th day of storage the flavor scores of the restructured chicken slices containing

Table 4 Effect of different leaf powders on the flavour scores of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Reference	Drumstick leaf	Mint leaf	Curry leaf
1	7.4 $\pm$ 0.71	6.8 $\pm$ 0.96	7.4 $\pm$ 0.77	7.0 $\pm$ 0.69
6	7.3 $\pm$ 0.69	6.7 $\pm$ 1.08	7.3 $\pm$ 0.56	7.0 $\pm$ 0.78
10	7.2 $\pm$ 0.70	6.7 $\pm$ 0.80	7.3 $\pm$ 0.80	7.0 $\pm$ 0.65
14	7.1 $\pm$ 1.01	6.7 $\pm$ 0.86	7.5 $\pm$ 0.79	6.8 $\pm$ 0.76
17	7.0 $\pm$ 0.69	6.6 $\pm$ 0.87	7.2 $\pm$ 0.93	6.8 $\pm$ 0.74
20	7.0 $\pm$ 0.85	6.6 $\pm$ 0.97	7.2 $\pm$ 0.76	6.7 $\pm$ 0.73

Table 5 Effect of different leaf powders on the juiciness scores of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Reference	Drumstick leaf	Mint leaf	Curry leaf
1	7.5 $\pm$ 0.72	7.1 $\pm$ 0.92	7.4 $\pm$ 0.57	7.2 $\pm$ 0.63
6	7.5 $\pm$ 0.58	7.1 $\pm$ 0.77	7.3 $\pm$ 0.62	7.1 $\pm$ 0.67
10	7.4 $\pm$ 0.50	7.0 $\pm$ 0.80	7.2 $\pm$ 0.88	7.1 $\pm$ 0.58
14	7.4 $\pm$ 0.71	7.0 $\pm$ 0.88	7.2 $\pm$ 0.84	7.1 $\pm$ 0.77
17	7.4 $\pm$ 0.64	6.9 $\pm$ 1.04	7.1 $\pm$ 0.85	7.0 $\pm$ 0.75
20	7.3 $\pm$ 0.69	6.9 $\pm$ 0.65	7.0 $\pm$ 0.77	7.0 $\pm$ 0.72

natural preservatives and reference samples were in the range of 6.6–7.0. However, Mandal et al (2002) and Sudheer et al. (2011) reported flavor scores of 6.3 and 6.1, respectively of restructured chicken products without any preservative on 10th day of storage indicating superior keeping quality of the products with natural preservative in the present study. On the contrary, Das et al. (2011) reported that goat meat patties with *curry* leaf powder (0.2 %) did not show any significant differences in odour scores compared to control samples which might due to the use of lower level of powder.

Sensory scores for juiciness was not significantly affected among the treatments and between the days of storage and the scores for all the groups ranged from 6.9 to 7.5 indicating very good juiciness of the products (Table 5). Texture and overall acceptability scores of the products had no significant effect among the treatments and between the days of storage (Tables 6 and 7). Slightly lower overall acceptability scores for *drumstick* leaf added products in the present study could be due to the slight bitterness of *drumstick* leaf powder. Hazra et al. (2011) reported that addition of *drumstick* leaf extract (1, 1.5 and 2 %) had improved the quality of cooked ground buffalo meat by enhancing its tenderness and juiciness. They also reported significantly ($P<0.05$) higher scores for overall acceptability than the control products. This higher overall acceptability scores in their study might be due to the use of *drumstick* leaf extract rather than whole leaves which might have eliminated the bitter compounds in the leaves. Mandal et al

Table 6 Effect of different leaf powders on the texture scores of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Reference	Drumstick leaf	Mint leaf	Curry leaf
1	7.3 $\pm$ 0.63	7.3 $\pm$ 0.84	7.5 $\pm$ 0.50	7.3 $\pm$ 0.55
6	7.2 $\pm$ 0.73	7.2 $\pm$ 0.70	7.3 $\pm$ 0.56	7.3 $\pm$ 0.73
10	7.2 $\pm$ 0.53	7.1 $\pm$ 0.79	7.3 $\pm$ 0.69	7.2 $\pm$ 0.63
14	7.2 $\pm$ 0.83	7.1 $\pm$ 0.77	7.3 $\pm$ 0.79	7.1 $\pm$ 0.79
17	7.2 $\pm$ 0.76	7.0 $\pm$ 0.75	7.1 $\pm$ 0.99	7.1 $\pm$ 0.71
20	7.1 $\pm$ 0.77	6.9 $\pm$ 0.75	7.1 $\pm$ 0.74	7.0 $\pm$ 0.58

Table 7 Effect of different leaf powders on the overall acceptability scores of restructured chicken slices during refrigerated storage (Mean $\pm$ SD)

Storage days	Reference	Drumstick leaf	Mint leaf	Curry leaf
1	7.3 $\pm$ 0.79	7.0 $\pm$ 0.89	7.4 $\pm$ 0.62	7.2 $\pm$ 0.61
6	7.2 $\pm$ 0.72	7.0 $\pm$ 0.83	7.3 $\pm$ 0.62	7.1 $\pm$ 0.71
10	7.2 $\pm$ 0.65	7.0 $\pm$ 0.97	7.3 $\pm$ 0.84	7.1 $\pm$ 0.65
14	7.2 $\pm$ 1.04	6.9 $\pm$ 0.75	7.2 $\pm$ 0.77	7.0 $\pm$ 0.69
17	7.1 $\pm$ 0.80	6.9 $\pm$ 0.69	7.1 $\pm$ 0.89	7.0 $\pm$ 0.97
20	7.0 $\pm$ 0.84	6.9 $\pm$ 0.89	7.1 $\pm$ 0.78	6.9 $\pm$ 0.80

(2002) reported comparatively lower scores of 6.3, 6.5 and 6.5 for juiciness texture and overall acceptability, respectively for restructured chicken product without any preservative. However, Sudheer et al. (2011) reported almost similar scores for juiciness (6.9) and texture (6.7) but lower overall acceptability scores (6.2) on 10th day of storage.

Conclusion

The data on SPC and sensory evaluation scores showed that the restructured chicken slices incorporated with the leaf powders were acceptable up to 20 days compared to the earlier reports of 10 days shelf life of similar products without natural preservative indicating the preservative efficacy of the leaf powders used in the present study.

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