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RESEARCH ARTICLE

Studies on the effect of Rice bran oil for the development of functional poultry product – Chicken shreds

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Abstract

Rice Bran oil (RBO) is edible oil with naturally balanced fatty acid composition quite close to the latest recommendations by the National Institute of Nutrition. Development of Ready-To-Eat poultry products with enhanced shelf life and good functional attributes is a major challenge to meat chemists. In the present study RBO and Sunflower oil (SFO) combinations at different levels were tried for the development of ready to eat chicken shreds with functional properties. Physico-chemical markers like proximate composition, Hunter color values, Thiobarbituric Acid Reactive Substance (TBARS), Peroxide value (PV), Free fatty acid (FFA), Total carbonyls, sensory evaluation and microbial profile were established initially and during refrigerated (4 ±1 ^{o}C) storage for 30 days. Correlation was established between lipid oxidative markers like Total carbonyls and TBARS and showed a quadratic fit model with R = 0.99. A significant decrease ($p<0.05$) in rancidity parameters were observed in RBO treated samples in relation with SFO. Initially sensory profile did not differ significantly ($p>0.05$) in all the samples but significant ($p<0.05$) decrease in overall acceptability scores were noticed after 30 days storage in SFO treated samples. Studies revealed the feasibility of employing RBO as a cooking medium for the development of poultry products with enhanced shelf stability.

Introduction

Rice bran oil (RBO) is a by-product of rice milling, having higher domestic value in many Asian countries. Nowadays, RBO is useful for cooking and promotes health due to its unique high level of unsaponifiable matters and gamma-oryzanol content (Gopala Krishna 2002). RBO is an edible oil with naturally balanced fatty acid composition quite close to the latest recommendations by the National Institute of Nutrition (NIN). It contains special nutraceuticals known to maintain the right balance of the cholesterol levels in the body. RBO contains oleic acid (38.4%), linoleic acid (34.4%), and linolenic acid (2.2%) as unsaturated fatty acids while palmitic (21.5%) and stearic (2.9%) acids as saturated fatty acids. A potential advantage of RBO over other oils with similar fatty acid composition is its oxidative stability imparted by the presence of high levels of tocopherol, tocotrienols, γ-oryzanol and its cholesterol lowering properties (Kim and Godber 2001; Wilson et al., 2000). It shows great promise for extensive use in India, due to the presence of several factors like γ-oryzanol, which are known to protect from cardiovascular diseases. These characteristics of rice bran oil make it more useful in applications of foods especially

for frying. It is excellent for frying due to its stability to heat, light viscosity and less oil being absorbed during cooking as compared to other edible oils. It leaves food without lingering, light tasting & enhanced palatability. Kamran et al., (2003) carried out studies on the incorporation of rice bran oil in cookies at various levels i.e. 0, 25, 50, 75 and 100 % by replacing shortenings to extend shelf life of the product. Fortification of high oryzanol rice bran oil to whole milk powder at 0.2% w/w significantly reduced free radical concentration in whole milk powder than addition of 0 % and 0.1% of rice bran oil (Nanua et al., 2002).

Fats are of vital importance as a source of energy and essential fatty acids and as carriers of fat soluble vitamins (Vuralet al., 2004). Meat and poultry products are a food category with both positive and negative nutritional attributes. Muscle foods are major sources for many bioactive compounds including iron, zinc, conjugated linoleic acid and B vitamins (Jimenez-Colmenero et al., 2001; Biesalski 2005). However, meat and processed meats are also associated with nutrients and nutritional profiles that are often considered negative including high levels of saturated fatty acids, cholesterol, sodium and high fat and caloric contents (Whitney and Rolfes 2008). Several studies also established a relationship between meat consumption and an increased risk of suffering serious health disorders such as colorectal cancer and coronary-heart diseases (Ferguson 2010). High animal fat diets are associated with several types of obesity, hypertension, cardiovascular diseases and coronary heart diseases (Ozvural and Vural 2008; Serranoet al.,2007; Vural and Javidipour 2002). Beef patties containing γ-oryzanol had higher oxidative stability during storage than beef patties with addition of other antioxidants (Kim et al., 2003). The cooked beef containing γ-oryzanol gave the lowest TBARS values, warmed over flavour scores, and C_7-oxidised cholesterol, hydroperoxide and hexanal levels.

Development of meat and poultry products with additional functional attributes such as improved oxidative stability and extension of shelf stability is one of the promising technological necessities to meet the demands of consumers. Therefore, the objective of this study is to develop poultry product with additional functional attributes with incorporation of rice bran oil and to investigate the effects of replacing animal fat with two different edible vegetable oils such as RBO and SFO.

MATERIALS AND METHODS

Raw materials

Fresh chicken (leg portion) was purchased from local market, Mysore, India within 1–2 h after slaughter and allowed rigor mortis to set in. The cuts were cut into uniform size pieces and washed thoroughly with water to remove foreign particles adhered to the surface of pieces and trimmed of all external fat. The Rice bran oil used in present investigation was obtained from Habib Agro Industries, Mandya, Karnataka, India.

Chemicals and Reagents

All the reagents and chemicals used for the study were of Analar grade and procured from M/s Sigma Chemicals, Corporation, USA and M/s BDH Company.

Preparation of Chicken shreds

Process flow chart for the preparation of chicken shreds with incorporation of rice bran oil is represented in Fig 1.

Sample codes:

A-100 % RBO
B- 75 % RBO+25 % SFO
C- 50 % RBO+50 % SFO
D-25 % RBO+75 % SFO
E- 100 % SFO

Proximate composition

Proximate composition for the RTE chicken shred was established as per AOAC methods (2000) for moisture, protein, fat, carbohydrate (by difference method) and total ash.

Determination of Hunter color values

Color values of RTE chicken shreds samples were determined using Hunter colorimeter (Color Flex, CFLX-45-2, Hunter lab, Reston, VA,USA) in terms of L*, a* and b* values as per the procedure given by Shand (2000). Measurement of the color co-ordinates were determined using a D-65 illuminant with a spectral range of 400-700 nm and a spectral resolution of 10 nm after standardizing the sensor using standard black and white colored tiles. CIE L* (lightness), a* (redness), b* (yellowness) values were recorded. The average of three measurements was taken for each sample.

Estimation of oxidative and hydrolytic rancidity parameters

Thiobarbituric acid reactive substances (TBARS) values were measured for chicken shred samples as an index of lipid oxidation according to the method of Taraldgis et al., (1960). The TBARS number is expressed as mg of malondialdehyde (MDA) per kg of sample. Peroxide value (PV) is a measure of the concentration of peroxides and hydro peroxides formed in the meat and meat products. PV and Free fatty acids (FFA) for the samples were determined as per the standard procedure of AOCS, 1998& 1993 respectively.

Total carbonyls

Total carbonyl expressed in terms of mg of n-hexanal / 100g fat was monitored by the method of Benca and Mitchela (1954).

Powdered/ground sample about 5g were extracted in 50 ml of carbonyl free benzene (to one litre of benzene, 5g of Dinitrophenyl hydrazine (DNPH) and one g of trichloroacetic acid were added. The contents refluxed for an hour and distilled) by shaking in mechanical shaker for an hour. Into 50 ml volumetric flask, 5 ml sample filtrate and 3 ml of 3 to 4% trichloracetic acid (in benzene) and 5 ml of 0.05% DNPH solution (in benzene) were added and incubated at 60^0 C for half an hour to convert free carbonyl into hydrazones. After cooling for 10 min, 4 % alcoholic potassium hydroxide were added and volume was made up to 50 ml with carbonyl free ethanol (to 1 litre of alcohol 7g of aluminium powder and 10g of potassium hydroxide were added. The contents were refluxed and distilled). After 10 min, absorbance was read at 480 nm. Blank were prepared in the same manner substituting 5ml benzene instead of sample extract.

A standard curve was drawn using hexanal (50 to 250 mg) in 5 ml benzene instead of sample extract. Total carbonyls were calculated with the help of standard curve and expressed as mg of hexanal/100g of fat.

Sensory evaluation

Sensory evaluation of chicken shred samples were carried out by 13 semi-trained panellists on a 9 point hedonic scale (9- like extremely, 1- dislike extremely) as per Murray et al., (2001) to establish the overall acceptability of the product.

Microbiological analysis (Total Viable Count)

Ten grams of samples were homogenized make and made with 90 ml of sterile normal saline (0.85%) for 1 min. The homogenized sample was serially diluted using 9 ml sterile saline (0.85%) and 0.1 ml aliquot of the appropriate dilutions was inoculated on plate count agar. Plates were incubated for 48 h at 37 °C (APHA 1992). Average counts from triplicates were calculated and expressed as colony forming units per gram (cfu g^{-1}) of the sample.

Statistical analysis

The data obtained were subjected to analysis of variance (ANOVA) and Duncan's multiple range test to evaluate the statistical significance of the treatments and significance was established at $p<0.05$.Curve expert 1.3 is used for correlation and regression analysis.

Results and Discussion

Proximate composition

Proximate composition for RTE chicken shreds has been represented in Table 1. From the table it can be interpreted that the product is a good source of quality protein and fat having a percentage of 14.92 and 18.34

respectively. It is a ready to eat product with 64.2 % moisture and lower amount of carbohydrates (1.3 %) providing 230 kcal per 100 g of the product.

Determination of Hunter color values

Color is a sensory property with a strong influence on food acceptance as it contributes decisively to the initial perception that one can acquire of the condition, degree of processing, and other characteristics of foods (Alos et al., 2006). Color characteristics of the product in terms of L* (Lightness), a* (redness) and b* (yellowness) were determined for the samples developed with RBO and SFO initially and during refrigerated storage (4 $\pm 1^{o}$C) for 30 days and the values are represented in Table 2. From the Table it is observed that there was an increase in the lightness (L* values) with increase in the levels of SFO incorporation in the product but the increase was not significant ($p>0.05$) initially and also during 30 days of refrigerated storage. Other color coordinates like a* and b* were found to be decreased during refrigerated storage for the samples treated with SFO but the changes were not significant ($p>0.05$) as reflected in Table 2. The changes in color values for were determined with the help of Hunter colorimeter and results revealed that no significant ($p>0.05$) difference was found with addition of RBO and SFO oils for the development of the product and same trend was observed during refrigerated storage also. Myoglobin and haemoglobin are the major pigments that are usually present in the meat and poultry products which are responsible for color characteristics. The increase in the L* values and decrease in a* values during refrigerated storage usually being attributed to the oxidation of heme pigments in the meat and poultry samples (Fernandez et al., 2005).

Evaluation of oxidative and hydrolytic rancidity parameters

Lipid peroxidation is one of the primary causes of quality deterioration in meat and meat products, and generates compounds that may be detrimental to human health. The conversion of muscle to meat after slaughter destroys the balance between prooxidative and antioxidative factors, resulting in initiation and propagation of oxidative changes. Oxidative stability of the product developed with addition of RBO and SFO initially and during refrigerated storage has been evaluated for TBARS, PV and FFA as quality chemical markers. The data pertaining to TBARS, PV and FFA are depicted in Figs 2, 3 and 4 respectively. From the results it can be interpreted that significant ($p<0.05$) increase was observed in both hydrolytic and oxidative rancidity markers during refrigerated storage for the sample D and E. Lipid oxidation limits the shelf life of the meat and poultry products during storage and both hydrolytic and oxidative rancidity should be considered as the former promotes later (Aguileria et al., 2000). Significant ($p<0.05$) decrease in TBARS, PV and FFA values were observed in samples with higher levels of RBO during refrigerated storage. Chicken shred samples prepared with incorporation of RBO is able to inhibit the oxidation and showed better oxidative stability compared to SFO incorporated samples. This could be due to the presence of natural antioxidant components such as tocopherols, tocotrienols and Gamma Oryzanol present in RBO (Nystrom et al.,2007).

Total carbonyls

Total carbonyls formations in the ready to eat chicken shreds samples were established initially and during refrigerated storage and the results are represented in the Fig 5. From the results it could be observed that significant ($p<0.05$) increase in the total carbonyl content was noticed during the refrigerated storage and the levels formation of carbonyl compounds in samples with higher levels of RBO were less compared to the samples with higher levels of SFO. Total carbonyls can be considered as a quality marker for the Warmed-over-flavour (WOF) development (Jayathilakan et al., 2007) of meat products which can be responsible for rancidity developments. Oxidative degradation of unsaturated fatty acids present in the meat and poultry systems yields an undesirable flavour and odour due to the formation of aldehydes, ketones, alcohols etc. Expressing these in terms of WOF profile by determining the hexanal content is an important tool to evaluate the development of the same during peroxidation of lipids.

Correlation between Total carbonyls and TBARS values of Chicken shreds during storage

To establish the correlation between different parameters like total carbonyls and TBARS values in chicken shred samples during storage, regression analysis was carried out and the fit of equations were determined for the data with maximum correlation coefficient and minimum standard error.Quadratic correlation regression analysis was performed using the software curve expert 1.3and represented in Fig 6. Quadratic fit equation established between total carbonyls and TBARS values is given below

Quadratic Fit: $y = a+bx+cx^2$

$y = -2.3064+9.8572X+-7.7247X^2$

Standard Error: 0.03608

Correlation coefficient (R): 0.99387

Sensory Evaluation

Sensory attributes of the products developed with the addition of varied levels of RBO and SFO were evaluated for Overall acceptability (OAA), initially and during refrigerated storage. Examination of the organoleptic characteristics by semi-trained panelists was carried out at an interval of five days for a period of 30 days and the score obtained has been depicted in Table 3. Results revealed that OAA of the product developed with RBO and SFO did not show significant ($p<0.05$) difference initially with 8.34±0.45 and 8.04±0.48 respectively. Products developed with higher levels of RBO showed higher OAA compared to samples with higher levels of SFO during refrigerated storage. Significant ($p<0.05$) difference was observed after 30 days of refrigerated storage in OAA of the RBO and SFO treated samples showing higher scores for products developed with higher levels of RBO, 7.44±0.35 and 6.62±0.46 respectively. Presence of functional components in RBO like Oryzanol, tocopherols and tocotrienols are involved in the extension of the shelf of the products with better retention of the nutritional profile and sensory attributes initially and during refrigerated storage (Orthoefer 2004). The physico-chemical markers and microbial profile are in correlation with the sensory analysis.

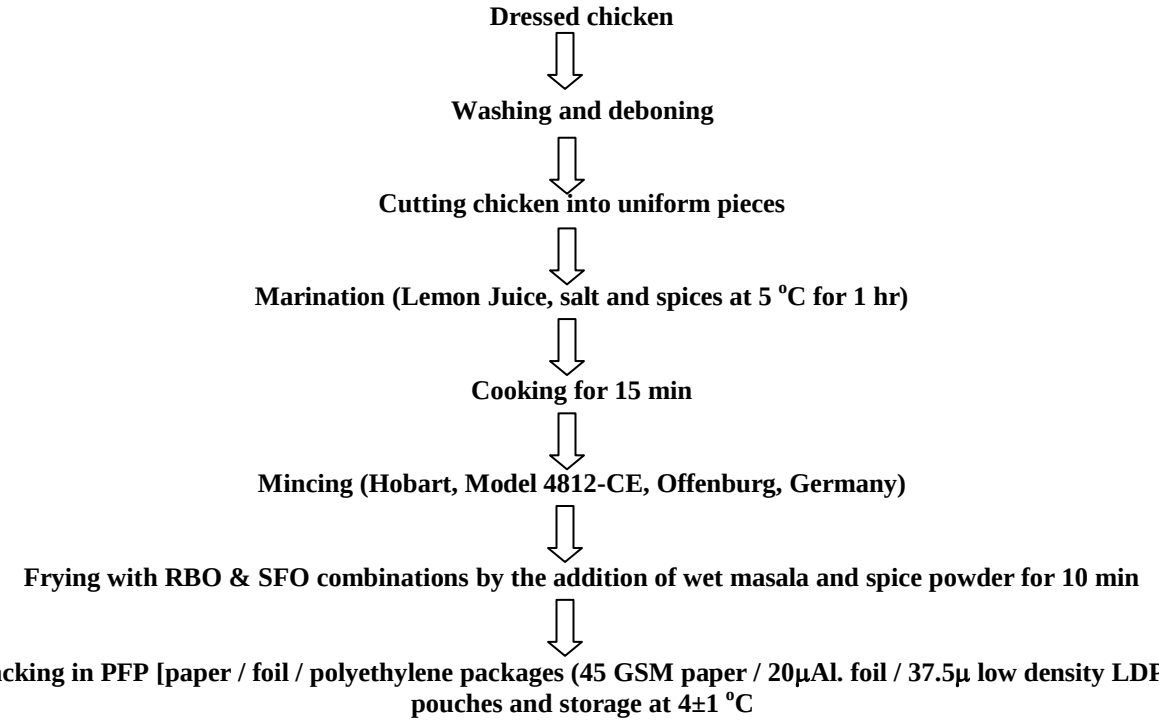
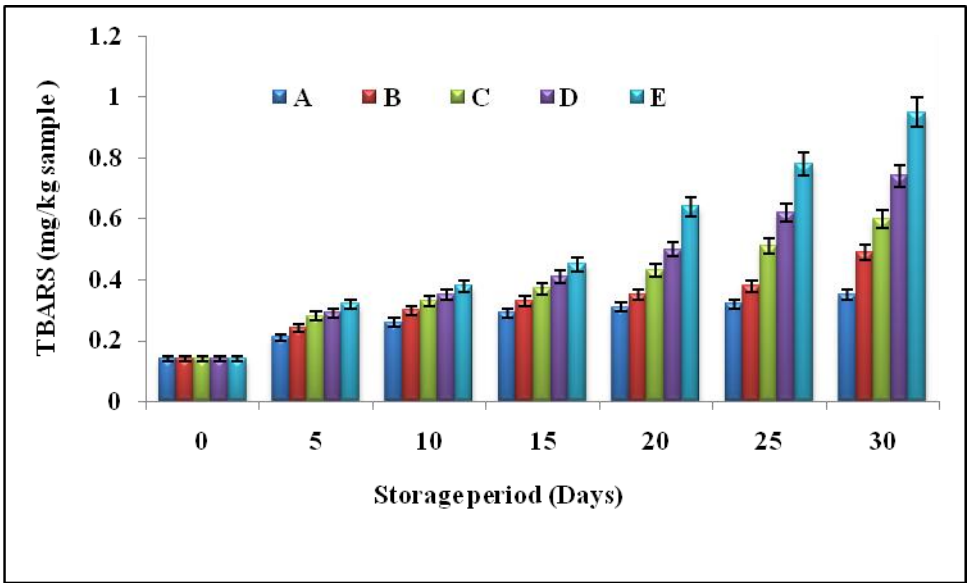
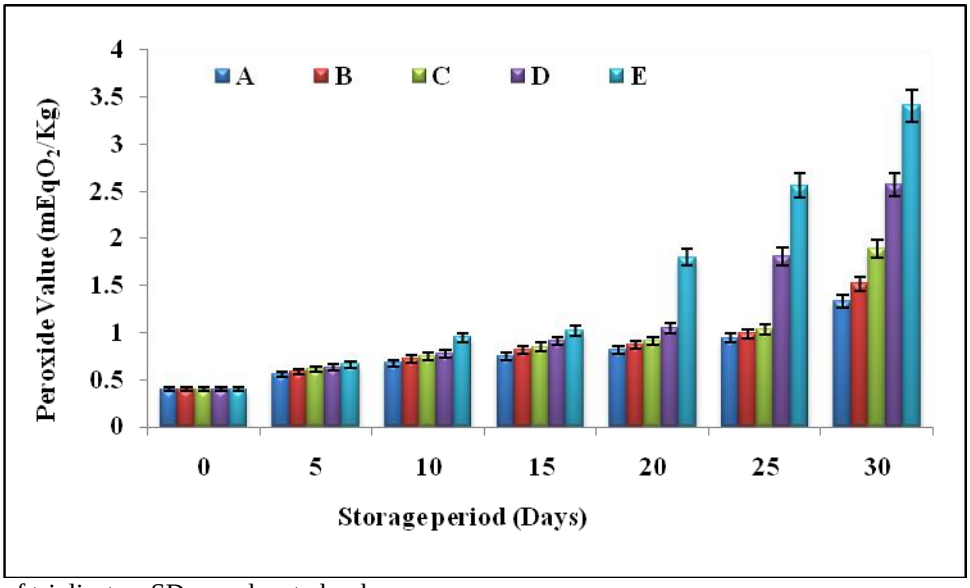


Figure 1: Process flow chart for the preparation of chicken shreds



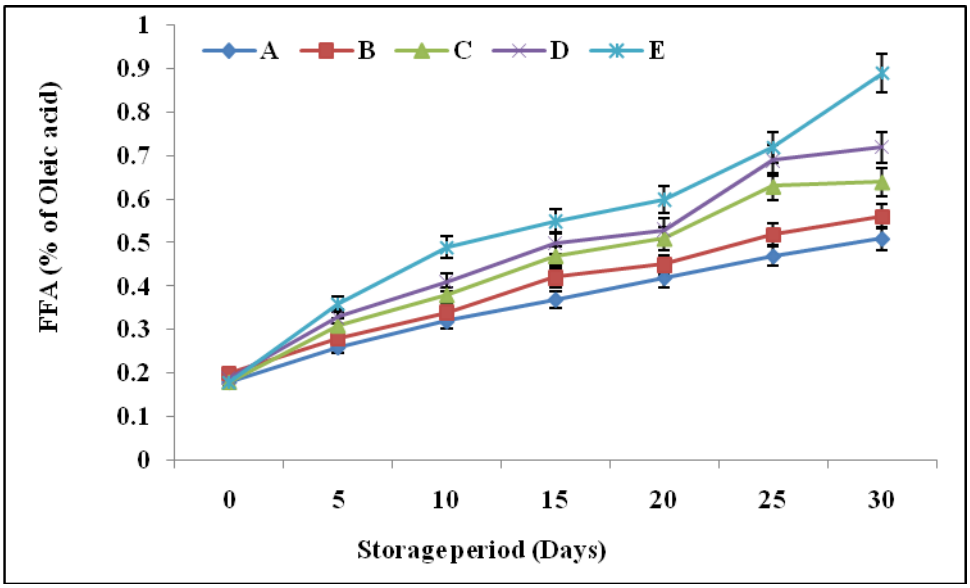
Mean values of triplicates; SDs are denoted as bars.

Figure 2: TBARS values for chicken shreds during refrigerated storage (4 ±1°C).



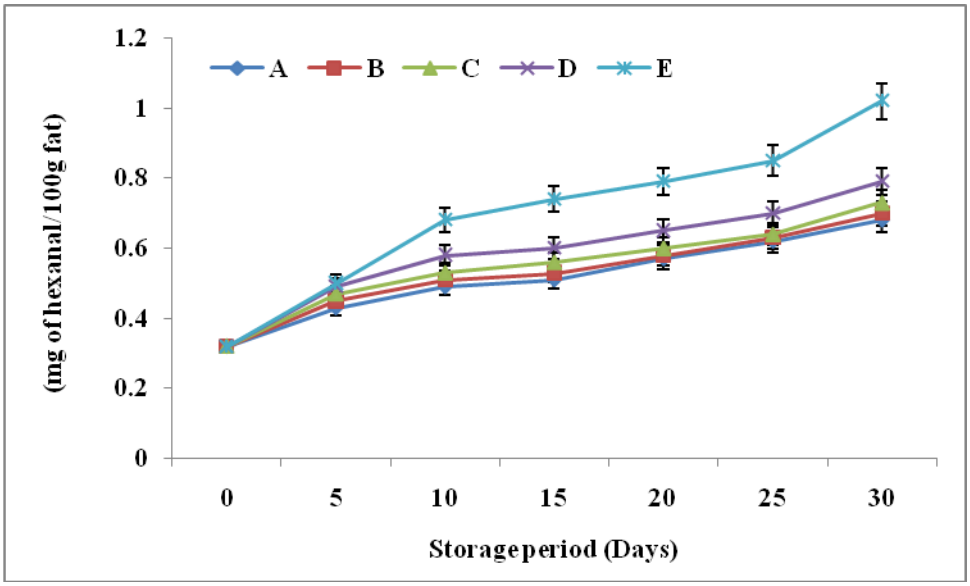
Mean values of triplicates; SDs are denoted as bars.

Figure 3: Peroxide values for chicken shreds during refrigerated storage (4 ±1°C).



Mean values of triplicates; SDs are denoted as bars.

Figure 4: Free Fatty Acid values for chicken shreds during refrigerated storage (4 ±1°C).



Mean values of triplicates; SDs are denoted as bars.

Figure 5: Total carbonyl for chicken shreds during refrigerated storage (4 ±1°C).

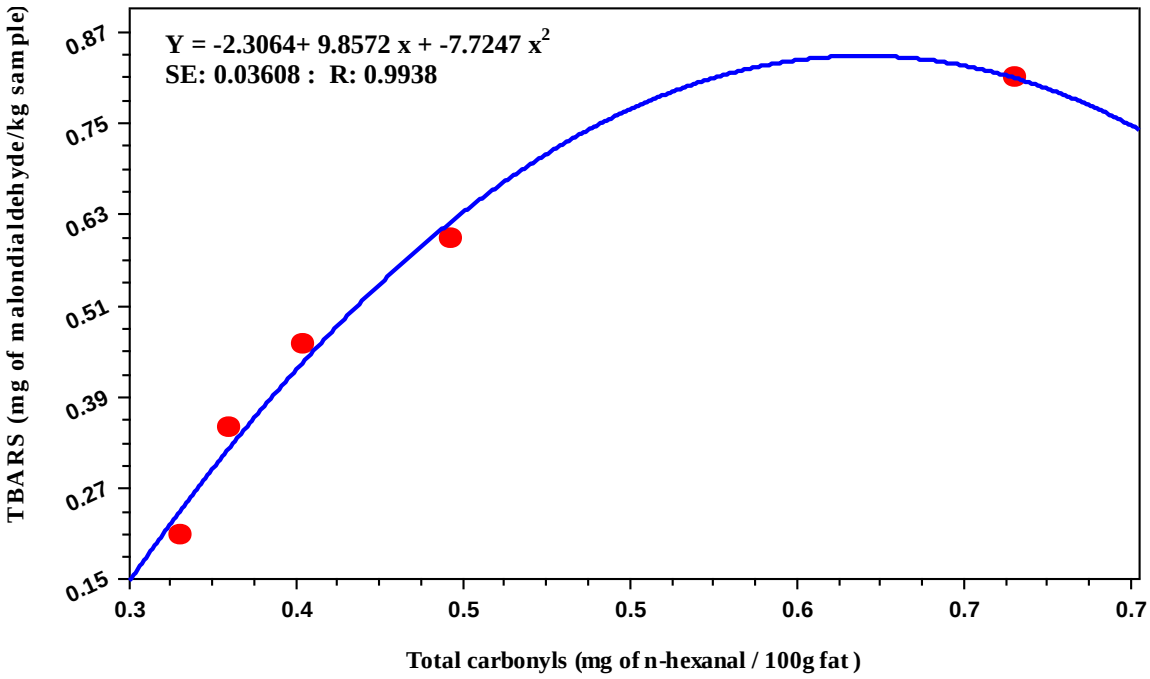
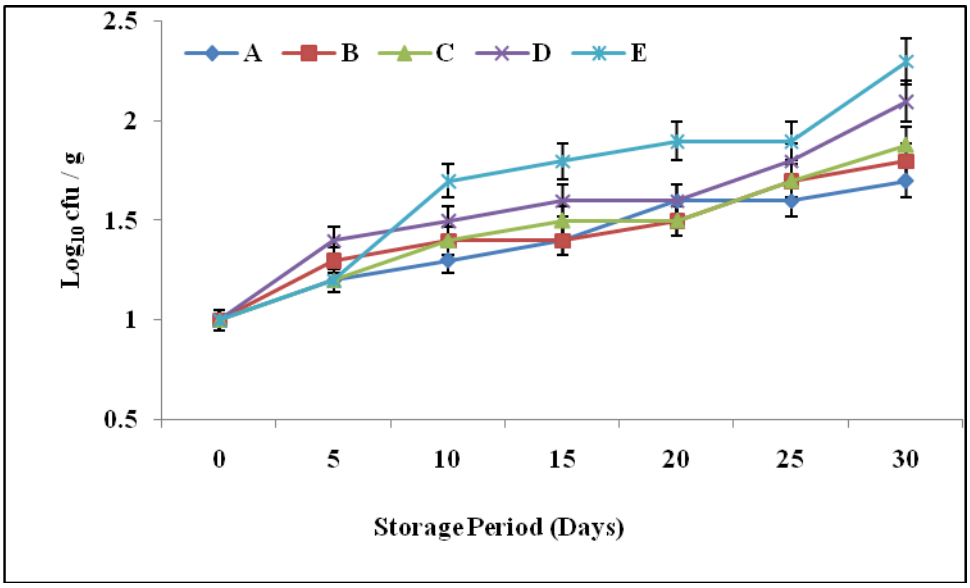


Figure 6: Quadratic fit for the TBARS and Total carbonyls for ready to eat chicken shred samples



Mean values of triplicates; SDs are denoted as bars.

Figure 7: Microbial profile (TVC) of chicken shreds during refrigerated storage (4 ±1°C).

Table 1: Proximate composition of Ready to eat Chicken shreds

Parameters	Proximate composition (g/ 100g)
Moisture	64.2 ±1.30
Protein	14.92±0.82
Fat	18.34±0.65
Total Carbohydrate	1.3±0.17
Ash	0.98±0.03
Energy(kCal)	230

All values are means ± standard deviation of data from three independent experiments.

Table no 2: Hunter color values (L*, a* and b*) of Ready-to-Eat chicken shreds during refrigerated storage

Hunter color parameters	Storage period (Days)	Samples					Overall Mean ± S. E.
		A	B	C	D	E	
L *	0	52.42±2.14	52.71±1.81	53.15±1.14	53.34±1.10	53.66±2.54	53.06±0.49[a]
	5	52.58±1.89	52.99±1.55	53.24±1.92	53.68±1.55	53.79±2.13	53.26±0.50[a]
	10	52.72±1.24	53.14±1.89	53.39±2.31	53.84±1.98	53.96±1.81	53.41±0.51[a]
	15	52.87±1.48	53.31±1.27	53.52±2.15	53.92±1.45	54.12±1.02	53.55±0.50[a]
	20	52.92±1.65	53.45±1.67	53.67±1.50	54.14±1.67	54.26±1.44	53.69±0.54[a]
	25	52.98±1.05	53.52±1.11	53.72±1.24	54.23±1.43	54.31±1.24	53.75±0.55[a]
	30	53.02±1.75	53.61±1.23	53.8±1.38	54.33±1.81	54.41±1.23	53.83±0.57[a]
a*	0	11.33±0.94	10.11±0.77	9.9±0.21	9.87±0.4	9.46±0.67	10.13±0.71[a]
	5	11.31±0.57	10.08±0.51	9.81±0.67	9.72±0.29	9.38±0.46	10.06±0.74[a]
	10	11.27±0.66	9.89±0.26	9.75±0.35	9.6±0.33	9.27±0.37	9.96±0.77[a]
	15	11.18±0.41	9.78±0.48	9.7±0.21	9.51±0.28	9.17±0.84	9.87±0.77[a]
	20	10.94±0.12	9.41±0.51	9.54±0.20	9.34±0.34	9.05±0.64	9.66±0.74[a]
	25	10.65±0.24	9.11±0.20	9.23±0.48	9.02±0.22	8.85±0.25	9.37±0.73[a]
	30	10.27±0.21	8.91±0.32	8.85±0.61	8.73±0.34	8.54±0.34	9.06±0.69[a]

	0	**49.91±1.55**	**48.8±1.56**	**48.59±1.01**	**47.87±1.26**	**46.05±1.94**	**48.24±1.43[a]**
	5	**49.8±1.26**	**48.72±1.87**	**48.37±1.26**	**47.62±1.42**	**46.01±1.62**	**48.10±1.41[a]**
	10	**49.68±1.48**	**48.57±1.69**	**48.27±1.48**	**47.41±1.11**	**45.82±1.11**	**47.95±1.44[a]**
b*	**15**	**49.51±1.35**	**48.43±1.23**	**48.14±1.04**	**47.28±1.35**	**45.66±1.25**	**47.80±1.44[a]**
	20	**49.2±1.67**	**48.22±1.24**	**48.02±1.28**	**47.08±1.28**	**45.36±1.34**	**47.58±1.45[a]**
	25	**48.74±1.29**	**47.93±1.57**	**47.64±1.41**	**46.79±1.67**	**45.13±1.58**	**47.25±1.37[a]**
	30	**48.35±1.97**	**47.55±1.23**	**47.24±0.68**	**46.58±1.67**	**44.88±1.34**	**46.92±1.31[a]**

All values are means ± standard deviation of data from three independent experiments. Different lowercase letters (a) in the same column indicate significant difference ($p<0.05$).

Table No 3: Sensory evaluation for Chicken shreds during refrigerated storage

Storage period (Day)	**Samples**					**Overall Mean ± S. E.**
	A	**B**	**C**	**D**	**E**	
0	**8.34±0.45**	**8.25±0.45**	**8.17±0.47**	**8.11±0.63**	**8.04±0.48**	**8.18 ±0.11[a]**
5	**8.12±0.45**	**8±0.42**	**7.84±0.45**	**7.7±0.45**	**7.5±0.59**	**7.83±0.24[b]**
10	**7.98±0.80**	**7.87±0.59**	**7.6±0.83**	**7.53±0.93**	**7.35±0.48**	**7.67±0.25[bc]**
15	**7.8±0.56**	**7.66±0.42**	**7.42±0.48**	**7.21±0.52**	**7.16±0.75**	**7.45±0.27[bcd]**
20	**7.72±0.42**	**7.5±0.48**	**7.33±0.50**	**7.2±0.42**	**7.01±0.45**	**7.35±0.27[cd]**
25	**7.55±0.45**	**7.4±0.51**	**7.21±0.48**	**7.11±0.63**	**6.85±0.24**	**7.22±0.26[d]**
30	**7.44±0.35**	**7.18±0.58**	**7.12±0.32**	**7.01±0.44**	**6.62±0.46**	**7.07±0.29[d]**

All values are means ± standard deviation. Different lowercase letters (a-d) in the same column indicate significant difference ($p<0.05$).

Microbiology

The changes observed in the microbiological profile in terms of Total Viable Count (TVC) for the product initially and during refrigerated storage has been analysed and results are shown in Fig7. From the fig, it could be seen that samples were found to have 1.1 $\log_{10}$cfu g^{-1} initially. One log increase in (TVC) was observed after 30 days of refrigerated storage. TVC in samples developed with RBO and SFO did not show significant ($p>0.05$) changes initially and during storage period. These studies are in correlation with earlier studies (Abubakar et al., 2011) in four Suya and Balangu meat products. Microbial counts for the samples are within the acceptable limit after 30 days of refrigerated storage.

Conclusion

Studies revealed the feasibility of employing RBO as a cooking medium for the development of functional poultry products with good shelf stability. Comparative evaluation of RBO with usual cooking oils like SFO resulted in a better acceptability of the products in terms of physico-chemical and sensory attributes. RBO acted as a good natural antioxidant in the inhibition of lipid oxidative changes due to the presence of tocopherol, tocotrienols and gamma oryzanol. In addition to the antioxidant properties this oil benefits in lot of other functional characteristics which can be explored in future studies. As such extension of shelf life of Ready-to-Eat meat and poultry products is a major challenge to meat industries and utilization of this cooking oil will definitely benefit in the development of meat and poultry products without the use of other synthetic antioxidants and preservatives. Application of this oil can be tried along with various emerging processing and preservation of meat and meat products and which will have a great potential for civilian and Armed forces.

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