Research Article

Storage Stability of Vacuum and Conventional Packed Dried Meat Product

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Abstract

This study was conducted to evaluate the effect of packaging methods and treatments on storage stability of dehydrated chicken meat. Dehydrated chicken meat were subjected to two different type of packaging treatment i.e. conventional packaging and vacuum packaging using high density polyethylene bags and two different type treatments i.e. sodium chloride only(raw sample) and sodium chloride with sodium nitrite (treated sample) and stored at ambient temperature. Fat content and microbiological attributes i.e. total plate count (TPC) and yeast and mold count (YMC) were examined on 0th, 15th, 30th, 45th, 60th, 75th, 90th, 105th, 120th, 135th and 150th day. Fat content of vacuum packaged sample were found significantly higher ($P<0.05$) than conventional packaged sample and fat content of sodium chloride plus sodium nitrite treated sample were observed significantly higher ($P<0.05$) than sodium chloride treated sample. Fat content value were found decreased during the storage both in vacuum as well as conventional packaged sample but the values significantly lower for vacuum packaged sample than conventional packaged sample. The treated sample showed a significantly higher fat content as compared to raw sample throughout the observation period ($P<0.05$). Microbiological studied revealed that microbial count in TPC and YMC increased significantly ($P<0.05$) with advancement of storage period in all cases. TPC and YMC of vacuum packaged sample were higher significant ($P<0.05$) as compared to conventional packaged sample. Treated sample showed significantly lower ($P<0.05$) TPC and YMC than raw sample during 150 days of storage. Vacuum packaging with nitrite treatment was found to be more effective to preserve the fat content and prevent the microbiological spoilage in dried chicken meat.

Keywords: Chicken meat, vacuum packaging, microbiological attributes and fat content

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Introduction

India, like other developing countries has demand of food for the increasing population that cannot be fulfilled by vegetable sources only. So meat and meat products are gaining popularity to meet the demands of growing population. Meat is a very important livestock food that is its widest sense includes all those parts of animal body that are used as food by man. Meat is a wonderful supply of top quality protein with all essential amino acids and it even have great amount of minerals and essential vitamins. Thus chicken is that the most generally accepted meat in India. Chicken is wide consumed poultry worldwide with calculable consumption of 94 million tonnes within the variety of chicken meat. Meat drying offers advantages not only as a way of preservation however additionally helps to reduce packaging and transportation cost by reducing the load and volume. Currently, dried meat products are often simply incorporated in food formulations and through preparation such as dried meat cubes in instant noodle cup. The sun drying and numerous drying technologies are often used to manufacture dried meats, like hot air drying [3], microwave-assisted freeze drying [5], superheated steam drying [10] and freeze drying [11]. Meat drying is to reduce the water content so that microbes can unable to survive [12].

The principle of meat preservation is preventing or delaying microbic spoilage, controlling the weight loss and any variations in taste without using cold chain system throughout distribution and storage of dried meat. Drying techniques principally place confidence in extending the keeping properties of the meat by reducing the water activity [6].

Information on shelf-life study of dried chicken meat is very limited reported food researchers. The main purpose of the present study was to determine the effect of Packaging methods and pretreatments on microbiological attributes and fat content of dried chicken meat during storage period.

Material and Methods

Sample preparation and pretreatment

Chicken meat was procured from local market of pantnagar, U.S. Nagar, U.K. The skin of chicken breast meat removed and cut the flesh normal to muscle fibers into 1 cm^3 of sample size using a sharp knife then sample was pretreated with a solution containing 3.5% of sodium chloride only (raw sample) and other treated with solution of 3.5% of sodium chloride plus 0.015 % of sodium nitrite. The chicken meat samples for both pretreatments dipped into solutions at 50°C for 10 minutes. The ratio of chicken meat to solution was 1:2 w/v. After pretreatment the chicken meat samples were removed from solution and spread on a screen to drain off the excess water. Pretreatment was carried out to avoid microbial growth and undesirable quality changes during hot air drying and storage period.

Hot air Drying

Both treated and raw samples dried at temperature of 65 ºC and air velocity of 5.5 m/s using high velocity hot air dryer (Specification: motor capacity 1.5 kilo watt, heater capacity 12 kilo watt, Timer 0-60 min (10 min interval) and temperature range 30-110 ºC) manufactured by Kilburn macneil and berry limited.

Vacuum packaging

The dehydrated chicken meat samples were packed in high density polyethylene bags in Invac vacuum packaging machine (Saurabh Engineer Ahmadabad) under -700 mm Hg of vacuum pressure. For quality analysis, these vacuum packaged chicken meat samples were placed on metal rack at room temperature.

Conventional packaging

The hand operated portable sealing machine of 8 inch length was used for sealing the high density polyethylene bags. The packed samples of chicken meats were kept on metal racks at ambient temperature and reopen to evaluate the quality attributes after 15 days during 150 days of storage

Quality attributes Analysis

Fat content

The AOAC 1984 [1] method was used for analysing fat content. The crude fat was extracted in Soxtlet apparatus using petroleum ether as the solvent. Five gram of coarsely grounded sample was weighed in thimble with the attention that sample should cover 1/2 or 2/3rd volume of thimble. The thimble was transferred to the extraction tube and attached with the oil flask. The unit was then operated for 2-3 h, for complete extraction of fat from the sample. The extracted sample was then weighed along with the flask, and the weight of fat recovered was obtained. The fat content was calculated by using following formula:

$$\text{Fat content} = \frac{\text{Weight of fat recovered}}{\text{Weight of sample}} \times 100 \qquad (1)$$

Microbiological analysis

Preparation of samples

Samples were prepared according to APHA 1992 [2]. The 11 g of sample was transferred to 99 ml of normal saline solution and serial dilution was prepared.

Total plate count (TPC)

The TPC was measured by APHA 1992 [2] method utilizing plate count agar. One ml of congruous dilution of sample was transferred aseptically to sterile petri-plates in triplicate. The plates were then poured with 10 to 15 ml of melt agar at temperature of 45 ºC. After solidification of melt agar, the perti-plates were incubated at 37 ºC for 24-48

hours. The colonies were counted with help of colony counter. The average figure of colonies was multiplied with dilution factor to obtain total count as colony form unit (CFU) per gram of sample

$$\text{Count per gram} = \frac{1}{\text{Dilution factor}} \times \text{Colonies counted} \quad (2)$$

Yeast and mold count (YMC)

For YMC, potato dextrose agar was utilized and its pH was adjusted to 3.5 ±0.1 utilizing tartaric acid as given in APHA 1992 [2]. Congruous dilution was taken in petri-plates and the medium was transferred and after solidification, the plates were incubated at temperature of 22 ºC for 2-3 days. Average figure of colonies for dilution was resolute and the yeast & mold in number per gram of sample were calculated. The average count was calculated by multiplying authentic count with pertinent.

Statistical Analysis

Statistical Analysis was carried out by full factorial three factors ANOVA to examine the effect of independents variables on qualities attributes of dried chicken meat during storage.

Results and Discussion

Effect on fat content (%) of dehydrated chicken meat during storage

Fat content of both chicken meat samples decrease as increases the storage period. This trend of decreasing in fat content is shown in **Figure 1**. Maximum value of fat content was observed on 0th day in all cases. Thereafter fat content decreased when storage period increased up to 150 day.

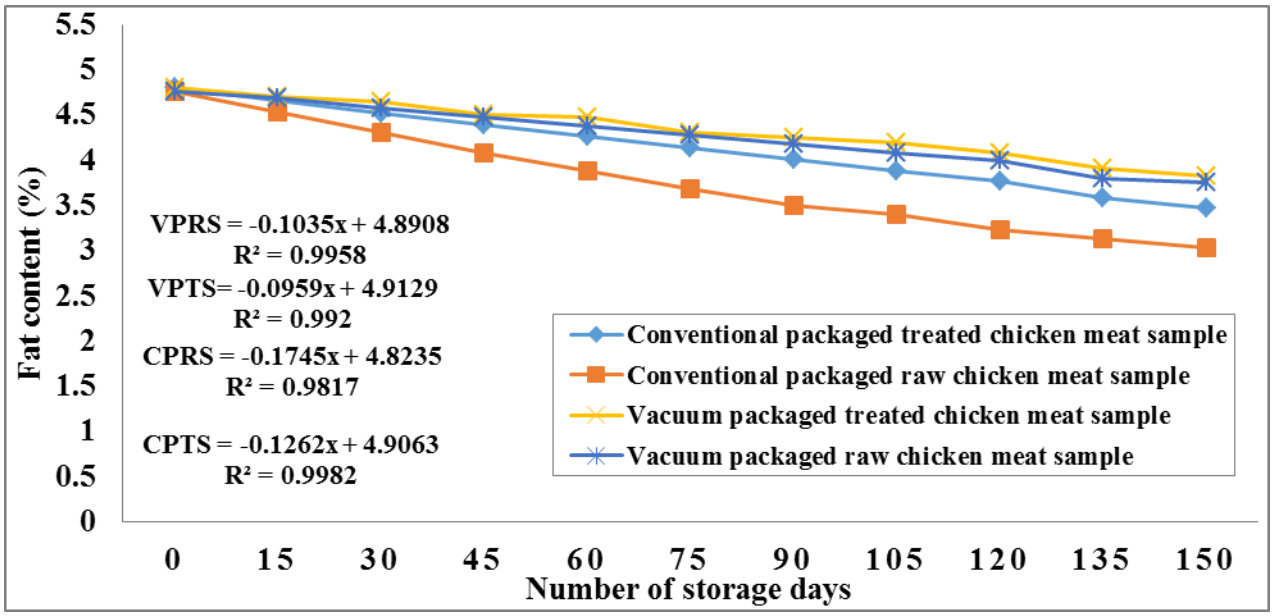

Figure 1 Effect on fat content of vacuum packaged and conventional packaged dehydrated chicken meat samples during storage period of 150 days at ambient temperature

The decrease of fat content with prolonged storage period, was observed because of lipoperoxidation occurred in dried meat during storage [8]. It was found that fat content of both treated and raw chicken meat sample decreased for both packaging methods. As shown in Fig.1, the treated chicken meat sample had more value of fat content than raw chicken meat sample for conventional packaging and vacuum packaging method. However for vacuum packaging of both raw and treated chicken meat samples, it was found that vacuum packaging was more effective to retard large amount of fat content throughout the storage period as compared to conventional packaging. Maximum fat contend was found to be 4.80 % on 0th day in conventional packaged treated chicken meat sample and vacuum packaged treated chicken meat sample and reduced to 3.54 % and 3.036 % respectively on 150 day of storage. But in case of conventional packaged raw chicken meat sample and vacuum packaged raw chicken meat sample, it was found

between the ranged of 4.76 % on 0th day of storage and decreased to 3.65 % and 4.12 % respectively on150 day of storage. Present study shows the fat content lost in all types of sample and packaging methods during storage. However it is cleared that vacuum packaged treated samples had maximum fat content on 150 day of storage.

From three factors analysis of variance, it was observed that maximum mean value of fat content was found 4.34% in vacuum packaged sample and minimum was 3.99 % conventional packaged samples. It was also found that maximum mean value of fat was 4.85 % on 0th day and minimum was 3.59 % on 150 day. These results showed effect of storage on fat content was observed to be significant ($p<0.05$). It was also observed that effect of packaging methods on fat content was found to be significant ($p<0.05$). It can be seen that effect of vacuum packaging on fat content was found highly significant ($p<0.05$) as compared to conventional packaging of both raw and treated chicken meat samples. Effect of interaction between storage and packaging on fat content was analyzed significant ($p<0.05$). The fat content decreased significantly when storage duration increased. It was concluded that effect vacuum packaging on fat was highly significant. However effect of pretreatment was observed as significant ($p<0.05$). Highest mean value of fat content was found to be 4.88 % on 0th day in raw chicken meat sample and decreased to 3.72 % on 150 day. The maximum mean value was obtained (4.28%) in treated chicken meat sample and minimum was 4.06 % in raw chicken meat sample. Effect of treatment on fat content was found to be highly significant ($p<0.05$) in treated chicken meat sample as compared to raw sample and effect of interaction between pretreatment and storage period was also found to be significant on fat content of chicken meat. However mean value of fat content was found to be 3.99 % in conventional packaged chicken meat sample and 4.34% in vacuum packaged chicken meat sample. It was also found that maximum mean value was 4.27% in treated chicken meat sample and minimum was found 4.06 % in raw chicken meat sample. Now this results shows effect of interaction between pretreatment and packaging was found be significant ($p<0.05$) and effect of these three factors on fat content was found to be non-significant.

From **Table 1**, it was found that F calculated value was observed maximum (428.70) for factor packaging followed by storage (260.87) and pretreatment (170.91) it is cleared that factors storage and pretreatment since F calculated value for factor packaging was greater than F tabulated value (2.053) at 5% significance level. It was also observed that interaction between pretreatment and storage had 80.867 for F calculated followed by interaction between storage and Packaging. This results showed that effect of interaction between storage and Packaging on fat content was significant because of higher F calculated value (10.85) than F tabulated value (2.053) but for Interaction among storage, packaging and pretreatment, F calculated value (1.862) was less than F tabulated value (2.053) thus showed the non-significant effect on fat content at 5% significance level. Coefficient of determination was 0.992 for vacuum packaged treated chicken meat sample and 0.9817 for conventional packaged raw chicken meat sample. It was also found that coefficient of determination was 0.9982 for conventional packaged treated chicken meat sample and coefficient of determination was found 0.9958 for vacuum packaged raw chicken meat sample. Result from regression analysis revealed that Fat content data were best fitted in linear polynomial equations as indicated the higher value of coefficient of determination (R^2).

Table 1 Three-way factorial design (ANOVA) for fat content of dehydrated chicken meat during storage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	F*
Factor storage period	10	16.020	1.602	260.878	2.053
Factor Packaging method	1	2.633	2.633	428.708	4.061
Interaction storage X Packaging	10	0.666	0.067	10.853	2.053
Factor Pretreatment	1	1.050	1.050	170.915	4.061
Interaction Storage X Pretreatment	10	0.183	0.018	2.983	2.053
Interaction Packaging X Pretreatment	1	0.497	0.497	80.867	4.061
Interaction Storage X Packaging X Pretreatment	10	0.114	0.011	1.862	2.0539
Error	44	0.270	0.006		
Total	87	21.432			

F*: 5% level of significance

Microbial changes in dehydrated chicken meat during storage

The microbiological study of dehydrated chicken meat samples was carried out during storage of 150 days at an interval of 15 days. For this study, total plate counts and yeast and molds counts were analyzed. The observed values of total plate count (TPC) and yeast and mold count (YMC) are presented in **Table 2**. TPC dehydrated chicken meat sample changed from 2.324 to 5.856 $\log_{10}$ cfu/gm and 2.556 to 6.841 $\log_{10}$ cfu/gm for conventional packaged of treated dehydrated chicken meat sample and raw dehydrated chicken meat sample respectively while for vacuum

packaged of treated dehydrated chicken meat sample and raw dehydrated chicken meat sample varied from 2.324 to 5.292 log_{10} cfu/gm for and 2.556 to 6.460 log_{10} cfu/gm respectively.

Table 2 Microbiological changes in dehydrated chicken meats during storage at ambient temperature

Storage days	Packaging	Type of samples	TPC (log_{10} cfu/gm)	Y&MC (log_{10} cfu/gm)
0	Conventional	Raw	2.556	ND
		Treated	2.324	ND
15	Conventional	Raw	2.835	0.690
		Treated	2.605	ND
30	Conventional	raw	3.991	1.035
		Treated	3.033	0.534
45	Conventional	Raw	4.303	1.173
		Treated	3.322	1.084
60	Conventional	Raw	4.539	1.306
		Treated	3.409	1.287
75	Conventional	Raw	4.763	1.380
		Treated	3.565	1.388
90	Conventional	Raw	5.201	1.518
		Treated	4.206	1.409
105	Conventional	Raw	5.372	1.725
		Treated	4.416	1.544
120	Conventional	Raw	6.180	1.863
		Treated	4.885	1.666
135	Conventional	Raw	6.423	1.960
		Treated	5.545	1.691
150	Conventional	Raw	6.841	1.997
		Treated	5.856	1.776
0	Vacuum	Raw	2.556	ND
		Treated	2.324	ND
15	Vacuum	Raw	2.835	ND
		Treated	2.605	ND
30	Vacuum	Raw	3.991	0.313
		Treated	3.033	0.780
45	Vacuum	Raw	4.303	0.345
		Treated	3.322	0.835
60	Vacuum	Raw	4.539	1.036
		Treated	3.409	1.178
75	Vacuum	Raw	4.763	1.063
		Treated	3.565	1.223
90	Vacuum	Raw	5.201	1.067
		Treated	4.206	1.310
105	Vacuum	Raw	5.372	1.174
		Treated	4.416	1.474
120	Vacuum	Raw	6.180	1.277
		Treated	4.885	1.522
135	Vacuum	Raw	6.423	1.450
		Treated	5.545	1.795
150	Vacuum	Raw	6.841	1.588
		Treated	5.856	1.833

Total plate count increased with prolonged storage period. However YMC in conventional packaged raw dehydrated chicken meat sample varied from 0.534 to 1.775 log_{10} cfu/gm and 0.692 to 1.997 log_{10} cfu/gm for conventional packaged treated dehydrated chicken meat sample while YMC varied from 0.313 to 1.588 cfu/gm for vacuum packaged treated dehydrated chicken meat sample and 0.780 to 1.833 log_{10} cfu/gm for vacuum packaged raw dehydrated chicken meat sample. It is cleared from this increasing trend of yeast and mold count from Table 2, it was observed that YMC growth started on 30^{th} day of storage for conventional packaged treated meat sample and for

conventional packaged raw meat sample on 15th day of storage. The growth of YMC started on 30th day in two types sample in vacuum packaged. Vacuum packaged chicken meat samples showed significantly lower microbial counts as compared to conventional packaged two type samples during storage. Microbial load of dehydrated chicken meats increased with increasing storage period [7].

Effect on TPC of dehydrated chicken meat during storage

Figure 2 shows TPC increased with increasing storage period at ambient temperature. Analysis of variance for TPC is presented in **Table 3**. From this table it can be seen that effect of pretreatments, packaging method and storage period and their interactions was found to be significant at 5% level of significance. For raw meat, the mean value of TPC was found 2.428775 (log_{10} cfu/gm) on 0th day of storage and 6.346 (log_{10} cfu/gm) on 150th day of storage whereas for sodium nitrite treated meat sample, it was found to be 2.428 (log_{10} cfu/gm) on 0th day of storage and 5.873 (log_{10} cfu/gm) on 150th day.

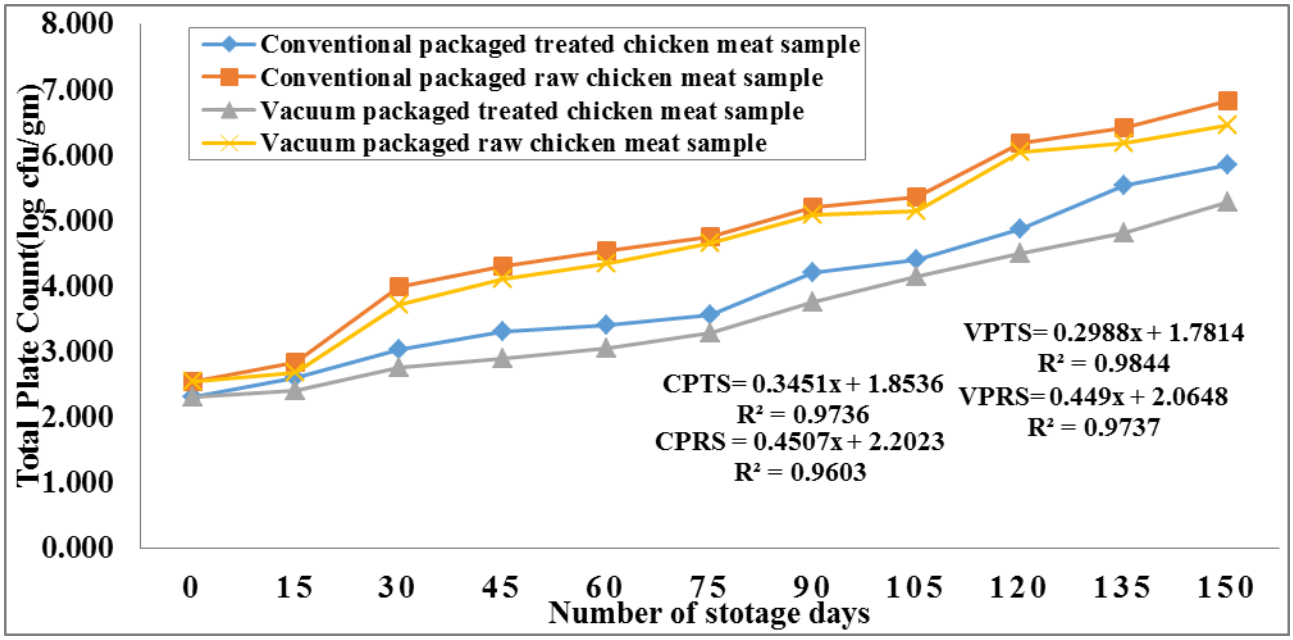

Figure 2 Effects on total plate counts (log_{10} cfu/gm) counts of vacuum packaged and conventional packaged dehydrated chicken meat samples during storage period of 150 days at ambient temperature

Table 3 Three-way factorial design (ANOVA) for TPC of dehydrated chicken meat during storage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	F*
Factor storage period	10	118.278	11.828	17,937.089	2.053
Factor Packaging method	1	1.500	1.500	2,274.738	4.061
Interaction storage X Packaging	10	0.357	0.036	54.107	2.053
Factor Pretreatment	1	21.232	21.232	32,198.306	4.061
Interaction Storage X Pretreatment	10	3.058	0.306	463.787	2.053
Interaction Packaging X Pretreatment	1	0.166	0.166	251.363	4.061
Interaction Storage X Packaging X Pretreatment	10	0.123	0.012	18.680	2.0539
Error	44	0.029	0.001		
Total	87	144.742			

F*: 5% level of significance

Overall mean value of TPC was 4.115 (log_{10} cfu/gm) for sodium nitrite treated meat and 4.376 (log_{10} cfu/gm) for raw chicken meat during storage. It is cleared that overall mean value of TPC for sodium nitrite treated meat sample was greater than raw meat. Thus effect of sodium nitrite on TPC was highly significant ($p<0.05$) as compared to without treatment. It was also observed that mean value of TPC increased with prolonged storage period. Results from analysis of variance, total plate count varied from 2.313 to 5.571 (log_{10} cfu/gm) and 2.544 to 6.647(log_{10} cfu/gm) for vacuum pack and conventional pack respectively. Overall mean value was found to be 3.754 (log_{10} cfu/gm) for vacuum pack and 4.736(log_{10} cfu/gm) for conventional pack. Therefore, effect of vacuum packaging on total plate

count was observed highly significant ($p<0.05$) in dehydrated chicken meats as compared to conventional packaging. This results agreed with findings were reported by Naveena *et al.*, 2014 [9].

From analysis of variance, results shows effect of pretreatment on total plate count was highly significant ($p<0.05$) in dehydrated chicken meat followed by storage period and packaging whereas effect of interaction between storage and pretreatment was found to be highly significant ($p<0.05$) as compared to interaction between packaging and pretreatment, interaction between storage and packaging, and interaction among storage, packaging and pretreatment. The result of regression analysis showed maximum value of coefficient of determination (0.9884) for vacuum packaged treated chicken meat and minimum (0.9603) for conventional packaged raw chicken meat however, coefficient of determination values were found to be 09736 and 0.9737 for the conventional packaged treated chicken meat and vacuum packaged raw chicken meat respectively. Total plate count data were best fitted in linear regression equations because of the coefficient of determination (R^2) was above 0.96.

Effect on YMC of dehydrated chicken meat during storage

From **Figure 3** it can be seen that yeast and mold count increased significantly when storage period increases. This figure shows yeast and mold count was detected on 15th day of storage for conventional packaged raw chicken meat sample and for all conventional packaged treated, vacuum packaged treated and vacuum packaged raw chicken meat samples on 30thday of storage. Effect of storage variables on YMC is presented in **Table 4**.

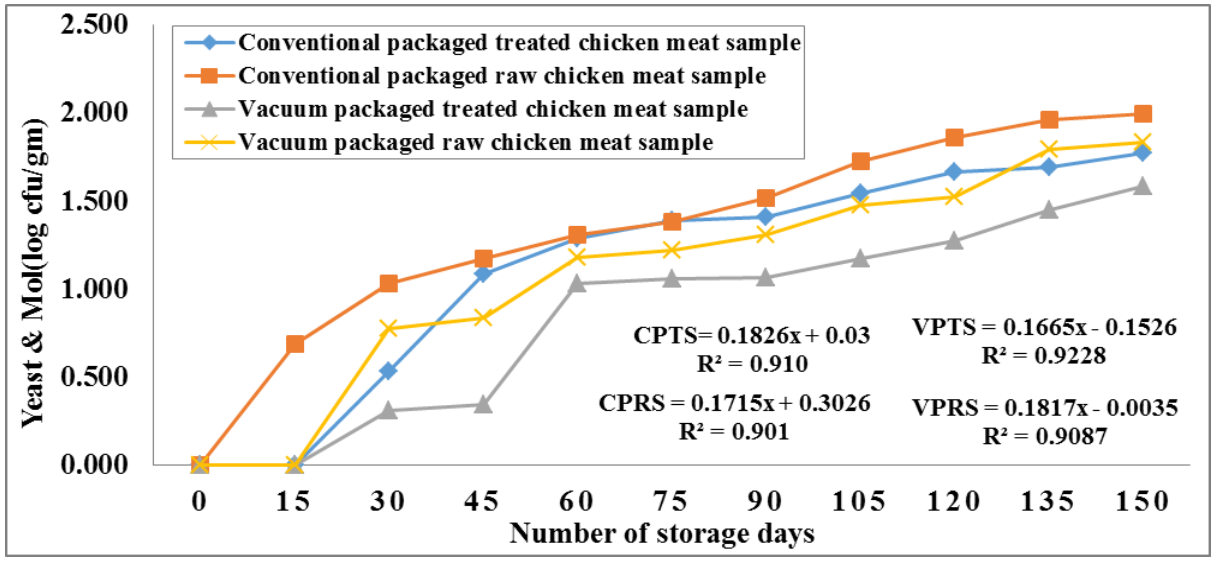

Figure 3 Effect on yeast and mold (log_{10} cfu/gm) counts of vacuum packaged and conventional packaged dehydrated chicken meat samples during storage period of 150 days at ambient temperature

Table 4 Three-way factorial design (ANOVA) for YMC of dehydrated chicken meat during storage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	F*
Factor storage period	10	30.398	3.040	3,447.850	2.053
Factor Packaging method	1	1.517	1.517	1,720.614	4.061
Interaction storage X Packaging	10	0.368	0.037	41.758	2.053
Factor Pretreatment	1	1.125	1.125	1,276.546	4.061
Interaction Storage X Pretreatment	10	0.389	0.039	44.149	2.053
Interaction Packaging X Pretreatment	1	0.006	0.006	7.091	4.061
Interaction Storage X Packaging X Pretreatment	10	0.364	0.036	41.239	2.0539
Error	44	0.039	0.001		
Total	87	34.206			

F*: 5% level of significance

From this table, it can be seen that the effect of storage variables (storage period, packaging and pretreatments) was found to be significant ($p<0.05$) and effect of their interactions was also observed to be significant ($p<0.05$). Minimum mean value of YMC was found to be 0.350 log_{10} cfu/gm on 15th day and maximum mean value was 1.924 log_{10} cfu/gm in raw chicken meat sample on 150th day of storage whereas for treated chicken meat sample, minimum mean value of YMC was found to be 0.555 log_{10} cfu/gm on 30th day of storage and maximum mean value was 1.745

$\log_{10}$ cfu/gm on 150th day of storage. This result is in agreement with the observation of Zakrys *et al.,* 2009 [13] who stated that beef packaged in vacuum had lower microbial load during storage. Overall mean value of yeast and mold count was 1.243 $\log_{10}$ cfu/gm for raw chicken meat sample and 0.980$\log_{10}$ cfu/gm for treated chicken meat sample. Thus effect of pretreatments on YMC in dehydrated chicken meat sample was found to be significant ($p<0.05$). Effect of sodium nitrite treatment YMC was found highly significant at 5% level of significance. For vacuum packaging of dehydrated chicken meat, mean value of yeast and mold was found to be 0.430$\log_{10}$ cfu/gm ON 30th day and 1.716 $\log_{10}$ cfu/gm on 150th day of storage while for conventional packaging, YMC was 0.350 $\log_{10}$ cfu/gm on 15th day of storage and 1.953$\log_{10}$ cfu/gm on 150 day of storage. Overall mean value of YMC was found to be 0.999 and 1.225$\log_{10}$ cfu/gm for vacuum packaging and conventional packaging of dehydrated chicken meat. From ANOVA Table 4, the effect of vacuum packaging on YMC was observed to be highly significant at significant at 5% level of significance. It was also observed that effect of storage period on YMC was highly significant ($p<0.05$) followed by packaging methods and pretreatments [4]. The Coefficient of determination were 0.9228 and 0.9087 for vacuum packaged treated chicken meat and vacuum packaged raw chicken meat respectively whereas it was found to be 09.10 for conventional packaged treated chicken meat and 0.901 for conventional packaged raw chicken meat. The regression analysis showed the YMC data were best fitted in linear regression model as the coefficient of determination was higher than 0.90.

Conclusion

Fat content decreased with prolonged storage in both vacuum packaged and conventional packaged samples, however it was higher for vacuum packaged as compared to conventional packaged sample throughout the storage period and differences were significant. The effect of sodium nitrite was observed highly significant than sodium chloride throughout storage. Effect on TPC for vacuum packaged was found to be highly significant as compared that of conventional packaged sample. TPC increased significantly and higher in conventional packaged than vacuum packaged. TPC increased with significantly increasing of storage period in both raw sample and treated sample. However raw sample had maximum the number of plate counts than treated sample during storage. YMC was found to significantly increase with increasing storage in both treated and raw sample. For treated sample, YMC was minimum than raw sample. YMC for vacuum packaged was highly significant than conventional packaged sample throughout storage. Dried chicken meat nitrite treated and vacuum packaged were relatively superior to sodium chloride treated and conventional packaged meat. Further there was no deterioration in quality of dried meat with increment of storage period in dried meat when other treatment and packaging method were used.

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