Introduction

The Effect of Packaging and Storage conditions on the Shelf life of Poultry

Summary and Conclusion

Meat can only be stored for future use through proper processing, packaging and storage. Though at present, processing of meat is very little in India, but rapid urbanization and changing life style demand ready to eat and convenient meat products. In addition to contributing to improved human nutrition and food security by being a leading source of high quality protein, poultry chicken is of Economic, Social and Cultural significance in small societies (FAO, 2010).

In the present study, the fresh chicken meats were vacuum packaged with Low Density Polyethylene (LDPE) with thickness of 50µm, 62.5µm, and 80µm and kept under refrigeration (4°C) and freezing (-18 °C and -24 °C) temperatures. On days 0, 15, 30, 45 and 60, three samples was taken from the refrigerator, freezer and analyzed for the physiochemical, microbiological and sensory characteristics.

Considering the importance of coating materials on enhancing the shelf life of food materials, the edible coatings of whey proteins concentrate and whey protein isolate with sorbitol were applied on meat samples separately by dipping method. The whey protein concentrate and whey protein isolate coated samples were vacuum packaged and stored at 4°C, -18 °C and -24°C and were subjected for analysis at regular intervals of 0, 7, 14 and 28 days of storage. Due to the refrigeration and freezing effect and vacuum packaging, the shelf life of the meat has been extended by reducing oxidation and the growth of aerobic microorganisms. The results obtained from the research are summarized below.

- The LDPE vacuum packaged chicken stored at refrigerated temperature (4°C) had shelf life of 15 days. Among the thickness of packaging materials, 62.5 and 80µm has on bar in quality during storage. The thickness 50 µm has significant (p<0.005) effect compared with the other thickness (62.5 and 80µm).
The shelf life of meat packed with LDPE films have high permeable to oxygen. Hence, the shelf life of vacuum-packaged meat was enhanced from 3 to 12 weeks, when stored at -24 °C.

Low temperatures storage has increased the shelf life of meat. Among the different storage temperatures studied (4 °C, -18 °C and -24 °C), the meat stored at -24 °C has maintained the tenderness of meat till the end of the storage period.

It was observed that the fat and protein content of chicken was decreasing with increasing the storage temperature and decreasing the thickness of packaging materials with respect to storage time. At different thickness studied the chicken packed in LDPE bag at 80µm thickness has maintained the fat and protein content during the storage periods followed by 62.5 and 50µm. Considering, the temperature the chicken stored at -24°C has maintained the fat and protein content followed by -18 °C and 4°C. The vacuum packed chicken stored at 4°C has shelf life of 15 days and the fat and protein value was found as 0.71 and 8.62 per cent respectively.

The least moisture content (73.07 per cent) was noticed in 50µm low density polyethylene (LDPE) vacuum packed chicken on 15th days of storage at 4°C was 74.95per cent. The moisture content of 62.5 and 80 µm low density polyethylene (LDPE) vacuum packed chicken on 60th day of storage at -18 °C and -24°C were 72.27 and 69.35; 66.68 and 72.86 per cent respectively. The initial moisture content of chicken meat was found as 77.28 per cent.

The change in ash content of chicken meat was found due to thickness (t), storage temperature (T) and storage period (S) was significant at 1 per cent level. Among the different temperatures, the ash content values found high in 4°C stored chicken meat compared with -18°C and -24°C. The ash content of samples coated with whey protein concentrate and whey protein isolate has not significant difference.

The water activity (aw) of meat sample from different packaging materials has not differed significantly. It is seen that the change in water activity in chicken meat due to LDPE thickness (t), storage temperature (T) and storage period
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(S) was significant at 1 per cent level. The $a_w$ value of meat sample stored at refrigerated temperature (4°C) has found higher value than freeze temperatures (-18°C, -24°C).

- A markedly higher pH value has found for meat samples stored at 4°C compared to those stored at -18°C (5.98) and -24°C (5.15) packed at 50µm thickness. The pH of coated chicken remained comparatively low. The chicken packed in LDPE bag at 80µm thickness has maintained the pH during the storage periods. The vacuum packed chicken stored at 4°C has shelf life of 15 days and the pH was found as 6.09.

- The loss in colour values ($l^*$, $a^*$ and $b^*$) during storage period was observed due to vacuum packaging and dilution of colour pigments. At different thickness studied the chicken packed in LDPE bag at 80µm thickness has maintain the colour during the storage periods. Considering the temperature, the chicken stored at -24°C has maintained colour values followed by -18 and 4°C. The vacuum packed chicken stored at 4°C has shelf life of 15 days and the colour value were found as 32.63 ($L^*$), 8.02 ($a^*$) and 16.76 ($b^*$) respectively.

- Microbial counts and rancidity levels have observed well below the permissible level of processed chicken. The initial micro flora of chicken meat is mesophilic and after carcass evisceration microbial load reaches to $10^2$–$10^4$ bacteria per cm$^2$. The vacuum packed chicken stored at 4°C has shelf life of 15 days and the TPC, *salmonella*, *staphylococcus*, *E-coli* were found as 42x10$^7$ cfu/ml, 30, 100, 20 respectively at the end of storage period on 60 days of storage. The initial microbial content of chicken meat was found as 10x10$^5$ cfu/ml. Among the different temperatures, TPC, *salmonella*, *staphylococcus* and *E-coli* values were found low in -24°C stored chicken meat compared with -18°C and 4°C.

- Thus the shelf life of meat vacuum packed using low density polyethylene (50µm, 62.5µm and 80µm) stored at -18°C and -24°C extended shelf life for two months and showed better physiochemical properties.
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- It was evident from the results that drip loss has not differed significantly for different whey proteins concentrated coating. Drip loss occurred due to moisture removal from frozen meat samples with the passage of time. The drip loss was found high in chicken packed in 50µm thickness.

- Considering the coating materials, the chicken coated with whey protein isolate (WPI) has found best in uniform coating and the drip loss was found less than compared with whey protein concentrate (WPC) coated and control samples.

- Considering the coating materials, sorbitol acts as Newtonian fluid whereas the WPI and WPC coating solutions were acting as non-Newtonian fluid. The viscosity of sorbitol was found as 2.40cP which is increased with increasing the spindle speed from 50rpm to 100rpm. The viscosity increases due to increase in shear rate with respect to spindle speed. The viscosity of WPI and WPC solutions were measured and it was found as 2cP and 2.4cP respectively.

- The whey protein isolate (WPI) coated chicken has maintained the quality parameters such as texture, colour, protein, fat and water activity during the storage than whey protein concentrate (WPC) coated samples.

- Considering the coating materials the WPC coated material has retained the hardness than WPI coated chicken during the storage periods. The WPI and WPC coated vacuum packed chicken stored at 4°C has shelf life of 28 days and the hardness values for WPI coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 0.24, 0.29 and 0.31 kgf respectively. Similarly, the hardness values for WPC coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 0.27, 0.33 and 0.37 kgf respectively. The initial hardness of chicken meat was found as 0.74.kgf.

- It is evident from the results that whey protein coating significantly affect the color L*, a* and b* values of meat samples. The storage period of edible coated meat samples also significantly increase the L*, a* and b* value meat samples.
The colour values (L*, a*, b*) for WPI coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 18.05 (L*), 0.64 (a*), 1.66 b*); 15.28 (L*), 0.56 (a*), 1.36 (b*) and 15.05 (L*), 0.54 (a*), 1.69 (b*) respectively. Similarly, the colour values (L*, a*, b*) for WPC coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 15.08 (L*), 0.69 (a*), 1.78 (b*); 15.18 (L*), 0.71 (a*), 1.53 (b*); and 14.75 (L*), 0.52 (a*), 1.62 (b*) respectively. The initial colour values of chicken meat was found as 16.14(L*), 0.684 (a*), 2.53 (b*).

Among the thickness of packaging materials used and storage period studied, the effect of 50 µm, 62.5µm and 80µm have significant effect on meat swelling capacity of chicken meat. Considering the interaction between storage period, thickness of packaging materials and temperature on meat swelling capacity was statistically P<0.05 per cent significant.

The initial pH of chicken meat was found as 6.14. The pH of chicken packed in 50µm, 62.5 and 80 µm LDPE film on 28th days of storage at -18°C and -24°C were 6.62 and 6.36 ; 6.48 and 6.34 ;6.34 and 6.52 respectively. Similarly, pH of WPC coated chicken packed in 50µm, 62.5 and 80 µm LDPE film on 28th days of storage at -18°C and -24°C were 6.38 and 6.43 ; 6.42 and 6.46; 6.47 and 6.45 respectively.

This study revealed that incorporation of whey powder did not affect the fat content of chicken meat. At different thickness studied the chicken packed in LDPE bag at 80µm thickness has retained the fat content during the storage periods. Considering the temperature, the chicken stored at -24°C has higher fat value followed by -18°C and 4°C.

Among the different treatments studied in WPI coating, the protein loss was found high in chicken packed in 50µm film and stored at -24 °C. The protein content of chicken packed in 50µm, 62.5 and 80 µm LDPE film on 28th days of storage at -18°C and -24°C were 10.43 and 10.42 ; 10.44 and 10.44; 10.44 and 10.45 per cent respectively. Similarly, protein content of WPC coated chicken packed in 50µm, 62.5 and 80 µm LDPE film on 28th days of storage at -18°C and -24°C were 10.45 and 10.51 ; 10.33 and 10.42; 10.43 and 10.41 per cent respectively.
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- The moisture content and fat content of chicken was decreasing with increasing the storage period and decreasing the thickness of packaging materials. Considering the coating materials the WPC coated material has retained the moisture content than WPI coated chicken during the storage periods. The ash content of chicken has not significant effect with thickness of film and storage temperature.

- The WPI and WPC coated vacuum packed chicken stored at 4°C has shelf life of 28 days and the Total Platelet Count (TPC) for WPI coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 19x $10^5$, 3x $10^5$ and 14x $10^5$ respectively. Similarly, the Total Platelet Count (TPC) for WPC coated chicken packed in 50, 62.5 and 80 µm LDPE were found as 24x $10^5$, 22x $10^5$ and 19x $10^5$ respectively. The initial Total Platelet Count (TPC) of chicken meat was found as 4x $10^5$.

- Considering the count of *staphylococcus*, *salmonella* and *E-coli* in chicken (WPI coating) packed in 50µm LDPE film on 28th days of storage at 4°C were 1x $10^2$, 5 and 7 respectively. Similarly, the count of *staphylococcus*, *salmonella* and *E-coli* of WPC coated chicken packed in 50µm LDPE film on 28th days of storage at -18°C and -24°C were 2x $10^2$, 8 and 10 respectively. Absence of *staphylococcus*, *salmonella* and *E-coli* in WPC and WPI coated chicken packed in 50µm, 62.5 and 80 µm LDPE film till 28th days of storage at -24°C.

- So the present study revealed that whey protein coated chicken had acceptable physico-chemical, safety microbiological counts during the storage period of refrigerated and freezer condition with vacuum packaging up to 28 days.

- The sensory analysis was done for whey protein isolate (WPI) and whey protein concentrate (WPC) and vacuum packaged chicken during the storage period. Among the treatment the chicken coated in whey protein isolate (WPI) packed in 80µm and stored at -24°C has high score value than the other treatments.

- The cost of packaging of whey protein isolate (WPI) coated, whey protein concentrate (WPC) coated and vacuum packaged chicken for 500g were found as Rs. 89.06, 89.10 and 89.10 approximately.
Conclusions

✓ Among the packaging materials, the thickness of 80µm LDPE film has retained all the Physico-chemical characteristics of vacuum packed chicken meat during storage at -24°C.

✓ Addition of whey protein coating materials has enhanced the shelf life of chicken meat with additional protein content.

✓ Among the coating materials, whey protein isolate (WPI) has uniform coating than whey protein concentrate.

✓ The whey protein coated samples have enhanced the shelf life of chicken meat for 28 days at -18 °C and -24°C of storage. Similarly, the shelf life of whey protein coated samples stored at 4°C has 28 days.

✓ The microbial load in the processed chicken meat at the end of storage day was found in safety recommended level at -18 °C and -24°C.

✓ The operating cost for production of 500 grams of processed chicken was found as Rs. 89.10. This cost will be reduced in large scale of production.

Recommendations

❖ The dramatic changes in the market forms for poultry in recent years, from a predominantly whole bird commodity to modern highly diversified industry focused on cut up, deboned meat and ready-to-eat further processed products, have resulted in a change of quality expectation. Therefore selection of packaging material would concentrate on product factors such as colour, stability, storage conditions, microbial condition, preservatives and degree of processing.

❖ Processed products require more sophisticated and extensive packaging because they will be stored at higher temperatures for longer periods than refrigerated products. The package has to be considered as an integral
part of the preservation system because it provides a barrier between the food and the external environment.

Chemical preservatives are being used globally to preserve food. These chemicals became harmful to humans, hence the use of natural preservatives can be recommended. More studies on these aspects can be taken when more natural preservatives can be identified and popularized.

Market factors which influence like distribution time/shelf-life, package size and cost, pre-market pricing and brand labeling need consideration.