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Microbiological quality evaluation of aerobic and vacuum packed broiler chicken carcass under different frozen temperature storage

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Abstract
Freezing is the process of extending the shelf life of broiler chicken meat. Since frozen meat is getting popular among the consumers, a study was undertaken to estimate the psychrophilic count, Streptococcal count and yeast and mould count in the frozen broiler chicken meat samples stored at -12 ºC, -18ºC, -24 ºC under aerobic and vacuum packaging for one year. There is a significant difference between (P<0.01) aerobic and vacuum packed samples at different storage temperatures pertaining to psychrophilic count. From ninth month to twelfth month of storage of samples, there was decreasing trend irrespective of aerobic and vacuum packaging along with temperature of storage. Over the period of 12 months of storage had a reduction of streptococcal count in the aerobic and vacuum packed samples with the temperature of -12 °C, -18 °C and -24 °C and showed a significant difference between (P<0.01) and among the treatments up to 12 months of storage. Aerobic and vacuum packed broiler meat samples with the temperature of storage at -12 °C, -18 °C and -24 °C had a significant decrease in yeast and mould growth over the 12 months of storage period and had a significant difference between (P<0.01) and among the treatments. Hence, the storage of frozen broiler chicken meat, either aerobic or vacuum packaging at -12 °C, -18 °C and -24 °C will help reduce the above microbial counts.

Keywords: broiler chicken meat, freezing, storage studies, psychrophilic, streptococcal and yeast and mould count

Introduction
Currently, consumption of broiler chicken is more popular in the different sections of people in the world because of advantages such as higher protein, easy digestibility and lower cost as compared to other meat of various food animals. Broiler chicken can be preserved for longer-term storage through canning, drying, or freezing. Now a days, utilization of frozen chicken is increasing over the years and is being marketed by many processing plants commercially. Freezing is one of the best preservation methods for broiler meat as compared with other methods, it leads to a minimal loss of quality during long-term storage. Frozen storage is used to retard undesirable bio- chemical reactions in meat, but there is some cell disruption and destruction of muscle fibre due to the formation of ice crystals [1]. The knowledge of practical storage life of chicken under frozen conditions is of commercial importance to poultry processors and consumers. There seems to be no evidence of literature on frozen broiler chicken meat's practical storage life under Indian conditions. To fulfil the gap, this study is envisaged to estimate the psychrophilic count, Streptococcal count and yeast and mould count in the samples stored under aerobic and vacuum packed frozen broiler chicken meat. Exploring these microbes under different storage conditions will pave a way for long term preservation of broiler chicken meat for utilization by the consumers and provide a successful mode of preservation commercially.

Materials and Methods
A total of 270 number blast frozen whole broiler chicken carcasses, divided into 3 groups each having 90 broiler chicken carcass each (45 aerobic and 45 vacuum packaged), were purchased from the commercial processing plant at Udumalaipet, Tirupur district, Tamil Nadu, India, with ten days interval for each group.

Three groups of six freshly slaughtered broiler chicken carcasses each were also procured from the same unit along with the regular frozen package and kept as control. The purchased broiler chicken (270 numbers of broiler whole chicken samples were transported to the Department of Livestock products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, Tamil Nadu, India and kept in the dedicated deep freezer, maintaining the sub-zero temperature of -12 ºC, -18 ºC and -24 ºC for 12 months. Broiler chicken carcass samples stored under different temperature will be drawn out one day before the experiment and it was thawed overnight in the chiller maintained at 4 ºC and the broiler breast muscles (*Musculus pectoralis*) were separated from the thawed carcass and utilized for the study of microbiological analysis such as psychrophilic count, Streptococcal count and yeast and mould count at an interval of 30 days for 12 months for each group and all the samples were analysed in duplicate for each parameter. The microbial load estimation was carried out as per the procedure described in the International Commission on Microbiological Specifications for Foods [2]. The specific agar media from Hi-Media laboratories Ltd, India were utilized for the microbial load studies.

A total of 5 g of breast meat sample were taken aseptically and homogenized with 45 ml of 0.1 per cent sterile peptone water using a sterile pestle and mortar to obtain an initial dilution of 10^{-1}. Serial tenfold dilution were made up to 10^{-4} in pre- sterilized test tubes containing 9 ml of distilled water. The sample preparation and spreading were carried out under laminar airflow.

Psychrophilic count is done by weighing 17.5 g of plate count agar was suspended in one litre of distilled water. The suspension was boiled, completely dissolved and autoclaved at 15 lb pressure per square inch for 15 min to sterilize the medium. The melted medium was cooled to approximately 45º C and held at 44 – 46 ºC. 15 ml media were poured into sterile petri dishes in duplicate and dried at 50 ºC for 1.5 hours 10 fold dilution of inoculum were prepared and using sterile pipettes 0.1ml of the dilutions were placed onto the surface of the agar in the correspondingly labelled petri dishes by using sterile 'L" shaped spreader the 0.1 ml inoculum was spread quickly and carefully over the surface of pre-poured petri dishes. The plates were incubated at 7º C for 10 days in a refrigerator. The number of colonies were counted and expressed as log10cfu/g of sample.

Streptococcal count is done by measuring 41.30 g of Edwards medium base agar was dissolved in one litre of distilled water and boiled to dissolve the medium completely and sterilized. Duplicate 0.1 ml of volume of inoculums of suitable dilutions were spreaded using sterile 'L" shaped spreader over the surface of pre-poured petri dishes. The plates were incubated at 35 C for 48 h. Counts were expressed as log10 cfu/g of sample.

Analysis of yeast and mould in the meat samples were carried out by using potato dextrose agar. The agar was dissolved in one litre of distilled water and boiled to dissolve the medium completely and sterilized. Duplicate 0.1 ml of volume of inoculums of suitable dilutions were spreadedd using sterile 'L" shaped spreader over the surface of pre-poured petridishes. The plates were incubated at 35 ºC for 48 h. Counts were expressed as log10 cfu/g of sample. The data generated from the study were pooled and statistically analysed [3].

Results and Discussion

The psychrophilic count (log_{10} cfu/g) of aerobic and vacuum packed frozen broiler chicken meat samples stored under three different storage temperature (-12 °C, -18 °C and -24 °C) conditions are presented in Table 1 and Figure 1. On day 0, all the samples had a similar psychrophilic count and there is no significant difference between the treatments and at the end of the first month of storage, aerobic packed chicken meat samples and vacuum packed frozen chicken meat samples had a significant difference ($P<0.01$) among them but within the treatment samples, the aerobic packed chicken meat sample stored under -12 °C had a higher count than the other treatments. This indicates that conditions of storage (aerobic and vacuum) and the temperature had an influence on the psychrophilic count. A higher reduction of psychrophilic count was in 1.14 log_{10} cfu/g in the vacuum packed and stored at -18 °C and lower reduction (0.42 log_{10} cfu/g) was observed in aerobic packed chicken meat sample stored under -12 °C. In the second month of storage the aerobic and vacuum packed frozen broiler chicken meat samples had a comparatively slight increase in the psychrophilic count but the increase is low in vacuum packed samples than the aerobically stored samples. Comparison of between treatments had a significant difference ($P<0.01$) among them. Again it is obvious that vacuum packed samples lower psychrophilic count than the aerobic packed samples. From third month to eight-month storage of samples, it was found that increasing trend between and within the treatments irrespective of the temperature of storage and conditions of package has selective influence on the psychrophilic count and had a significant difference ($P<0.01$) among them. From the ninth month to the twelfth month of storage, samples had a decreasing trend irrespective of aerobic and vacuum packaging and temperature of storage. The overall decrease in the psychrophilic count is evident from the F value throughout the storage period.

There is a significant difference between ($P<0.01$) aerobic and vacuum packed samples at different temperature of storage. Exceptionally, vacuum packed meat samples at -12 °C had a higher psychrophilic count than the aerobic stored meat samples at -12 °C. From these studies, it can be assumed that vacuum packaging with -18 and -24 °C had lower psychrophilic count than aerobic packaging.

The psychrophilic count in the imported frozen chicken meat carcasses at trading in Sulaimani markets, Iraq for the purpose of determining their quality for human consumption and reported a value of 1.95×10^4, 13.74×10^4, 7.60×10^4 and 12.16×10^4 cfu/g respectively. The frozen chicken thighs for two batches of three trademarks (CFU / g meat) were 4.62×10^4, 8.56×10^4, 0.55×10^4 respectively[4]. Freezing has lethal effect on some microorganisms by formation of ice crystals [5] and as a result the count decreased. In the present study, the mean value of psychrophilic count in aerobic and vacuum packed and stored at -12 °C, -18 °C and -24 °C had the lower psychrophiles could be due to good manufacturing practices which have a role in decreasing the count. It was reported that microbial shelf life and quality of frozen broiler chickens that prolong frozen storage did not cause substantial changes in the bacterial count of carcasses stored at (-12 ºC), as being decreased slightly when stored at (-18 ºC) [6]. International Commission on Microbiological Specifications for Foods confirmed that frozen poultry typically does not undergo microbial spoilage, but they also determined that storage temperature should be controlled to prevent fluctuation which

directly have an effect on microbial growth [7]. Our finding pertaining to psychrophilic count in frozen broiler meat with aerobic and vacuum packed, stored at -12 °C, -18 °C and -24 °C and Our results is in accordance with the results of various authors [4,5,6]. and adhere to the direction of the International Commission on Microbiological Specifications for Foods [7].

The streptococcal count (log_{10} cfu/g) of aerobic and vacuum packed frozen broiler chicken meat samples stored under three different storage (-12 °C, -18 °C and -24 °C) conditions are presented in Table 2 and Figure 2. On day 0, all the samples (before freezing) had a similar streptococcal count. There is no significant difference between and among the broiler meat samples whether aerobic or vacuum packed, irrespective of temperature of storage. The reduction in the streptococcal count is evident from the F value throughout the storage period.

During the first month of storage, streptococcal count of aerobic packed chicken meat samples and vacuum packed frozen chicken meat samples had a significant difference ($P<0.01$) between and within the treatments samples. A progressive decrease in the streptococcal count has been noticed among the samples and there is a significant difference ($P<0.01$) between aerobic and vacuum packed samples irrespective of temperature of storage (-12 °C, -18 °C and -24 °C). This indicates that temperature of storage had selective influence on lowering the streptococcal count at the end of first month.

Start from the second month of storage of broiler meat samples either with aerobic packed or vacuum packed, along with temperature of storage (-12 °C, -18 °C and -24 °C) had a selective decrease in the streptococcal count has been found. Further, there is a significant difference ($P<0.01$) between the aerobic and vacuum-packed samples has been noticed. Similarly, there is a significant difference ($P<0.01$) among the treatments has been found. Over the period of 12 months storage period had a reduction of streptococcal count in the aerobic and vacuum packed samples with the temperature of -12 °C, -18 °C and -24 °C. In the present study, as storage period increases, the streptococcal count decreases irrespective packaging conditions. Hence, it could be understood that aerobic and vacuum packed samples with the temperature of storage at -12 °C, -18 °C and -24 °C had a lethal effect on the growth of streptococci over the period from first month to twelfth month of storage.

The retail broiler meat shops of Ratnanagar Municipality, Bharatpur Municipality and Institute of Agriculture and Animal Science vicinity of Chitwan, Nepal had a streptococcal count of 6.5±0.2, 6.8±0.3 and 7.7±0.4 log_{10} cfu/g [8]. A value of < 5 x 10^2 for Streptococcus faecalis has been pointed out as specification for chicken meat as per Jordan microbiological specifications [9]. The frozen poultry meat stored (-18 °C) at 0, 24 and 48 hours had a faecal Streptococcus (log_{10} cfu/gm) count of 2.5, 3.4 and 3.62 for drum stick chicken meat and 1.1, 1.2 and 1.4 for breast meat [10]. The results of streptococcal count of the aerobic and vacuum packed broiler meat samples stored at -12 °C, -18 °C and -24 °C and the present results are in agreement with the findings of various authors [8-10].

The yeast and mould count (log_{10} cfu/g) of aerobic and vacuum packed frozen broiler chicken meat samples stored under three different storage (-12 °C, -18 °C and -24 °C) conditions are presented in Table 3 and Figure 3. On day 0, all the samples (before freezing) had a similar yeast and mould count (2.97 log_{10} cfu/g) and there is no significant difference between and among the broiler meat samples whether aerobic or vacuum packed, irrespective of temperature of storage. During the first month of storage, yeast and mould count of aerobic packed and vacuum packed frozen chicken meat samples had a significant difference ($P<0.01$) between and within the treatment samples. Compared to vacuum packed frozen chicken meat samples, the aerobic packed samples significantly higher yeast and mould count at the end of first month of storage pertaining to the temperature of storage.

A progressive decrease in the yeast and mould count has been noticed among the samples between aerobic and vacuum packed samples irrespective of temperature of storage (-12 °C, -18 °C and -24 °C) as compared to the fresh broiler meat. The temperature of storage had selective influence on minimizing the yeast and mould at the end of first month. During the second month of storage of broiler meat samples either with aerobic packed or vacuum packed and even with temperature of storage (-12 °C, -18 °C and -24 °C) had a significant decrease in the yeast and mould count has been noticed. A significant difference ($P<0.01$) between the aerobic and vacuum packed samples with various storage temperature has been noticed among the treatments and also within treatments. Up to 12 months storage period, had a significant reduction of yeast and mould count in the aerobic and vacuum packed samples with the temperature of -12 °C, -18 °C and -24 °C. The significant difference in the yeast and mould count is evident from the F value throughout the storage period of one year. In the present study, as storage period increases, the yeast and mould count also decreases irrespective packaging conditions as similar to Streptococcal count. Therefore, it is evident that the aerobic and vacuum-packed broiler meat samples with the temperature of storage at -12 °C, -18 °C and -24 °C had a drastic decrease on the yeast and mould growth over the 12 month of storage period.

As per the Food Safety Standards Authority of India [11], the yeast and mould count in ghe frozen meat should be less than 1 x 10^3 cfu/g. In the present study the yeast and mould count are within the limits of Food Safety and Standard Authority of India. The microbiological quality of frozen turkey meat sold in commercial outlets of Diyarbakır, Turkey and reported an average value of 2.2x10^4 cfu/g for yeast and mould count [12]. The incidence of mould contamination of frozen chicken meat-cuts and giblets distributed in Zagazig city, Egypt [13]. The obtained results revealed that frozen gizzards had significantly higher TMC followed by frozen livers, breast and thigh and the mean (log cfu/g) values in such samples were 3.60, 3.47, 3.17, 2.69 respectively and the results of yeast and mould count of the samples are in accordance with the findings of various authors [11-13].

Table 1: Changes observed in the Psychrophilic Count (log_{10} cfu/g) of aerobic and vacuum packed frozen broiler chicken under three different storage conditions (i.e. -12°C, -18°C and -24°C)

Storage Period	Aerobic Packaging			Vacuum Packaging			F Value
	Temperature of Storage						
	- 12ºC	- 18 ºC	-24 ºC	-12 ºC	- 18 ºC	- 24 ºC	
0 Day (Before Freezing)	2.27 ± 0.04^{E}	2.27 ± 0.04^{E}	2.27 ± 0.04^{EFG}	2.27 ± 0.04^{C}	2.27 ± 0.04^{E}	2.27 ± 0.04^{DEFG}	
1 Month	1.85 ± 0.05^{dB}	1.66 ± 0.05^{cA}	1.74 ± 0.06^{cdB}	1.49 ± 0.05^{bA}	1.13 ± 0.06^{aA}	1.21 ± 0.06^{aA}	30.131**
2 Month	2.04 ± 0.03^{bcCD}	1.87 ± 0.05^{abB}	1.86 ± 0.05^{abC}	1.93 ± 0.11^{bB}	2.15 ± 0.03^{cCDE}	1.67 ± 0.10^{aB}	5.311**
3Month	2.17 ± 0.03^{bE}	2.15 ± 0.03^{bCD}	2.21 ± 0.04^{bcEFG}	2.37 ± 0.05^{cC}	1.93 ± 0.12^{aC}	2.17 ± 0.07^{bDE}	4.843**
4Month	2.28 ± 0.03^{bEF}	2.25 ± 0.02^{bDE}	2.28 ± 0.03^{bEFG}	2.45 ± 0.05^{cCD}	2.00 ± 0.09^{aCD}	2.37 ± 0.03^{bcFG}	10.353**
5 Month	2.36 ± 0.06^{bFG}	2.36 ± 0.03^{bF}	2.28 ± 0.02^{bFG}	2.36 ± 0.04^{bC}	2.54 ± 0.06^{cG}	2.15 ± 0.02^{aDE}	9.392**
6 Month	2.58 ± 0.03^{cH}	2.45 ± 0.02^{bcF}	2.33 ± 0.04^{abG}	2.26 ± 0.04^{aC}	2.30 ± 0.09^{aEF}	2.19 ± 0.04^{aDEF}	8.494**
7 Month	2.62 ± 0.03^{cH}	2.35 ± 0.02^{bEF}	2.28 ± 0.02^{bEFG}	2.43 ± 0.10^{bCD}	2.16 ± 0.08^{aDE}	2.43 ± 0.03^{bG}	7.977**
8 Month	2.43 ± 0.04^{cdG}	2.15 ± 0.05^{aCD}	2.20 ± 0.03^{abF}	2.30 ± 0.08^{bcC}	2.50 ± 0.11^{dFG}	2.33 ± 0.03^{bcEFG}	7.870**
9 Month	2.22 ± 0.02^{aE}	2.11 ± 0.03^{aC}	2.16 ± 0.02^{aE}	2.58 ± 0.03^{bD}	2.17 ± 0.24^{aDE}	2.13 ± 0.04^{aD}	22.009**
10 Month	2.15 ± 0.04^{bcDE}	2.04 ± 0.03^{bC}	1.98 ± 0.05^{aD}	2.45 ± 0.06^{dCD}	2.21 ± 0.25^{cDE}	1.94 ± 0.06^{aC}	12.104**
11 Month	2.01 ± 0.07^{bcC}	1.91 ± 0.07^{bB}	1.84 ± 0.02^{bC}	2.36 ± 0.03^{dC}	2.10 ± 0.20^{cFGH}	1.64 ± 0.10^{aB}	15.829**
12 Month	1.72 ± 0.05^{bA}	1.66 ± 0.06^{bA}	1.57 ± 0.04^{bA}	1.92 ± 0.06^{cB}	1.37 ± 0.29^{aB}	1.33 ± 0.07^{aA}	12.302**
Average	2.21 ± 0.02	2.09 ±0.02	2.08 ± 0.02	2.24 ± 0.03	2.06 ± 0.46	1.99 ± 0.03	
F Value	39.856**	39.920**	45.461**	22.967**	30.430**	46.838**	

*Mean±S.E. with different superscripts row wise (small alphabet) and column wise (capital alphabet) differ significantly. n =6 for each treatment. ** Highly significant ($P<0.01$).

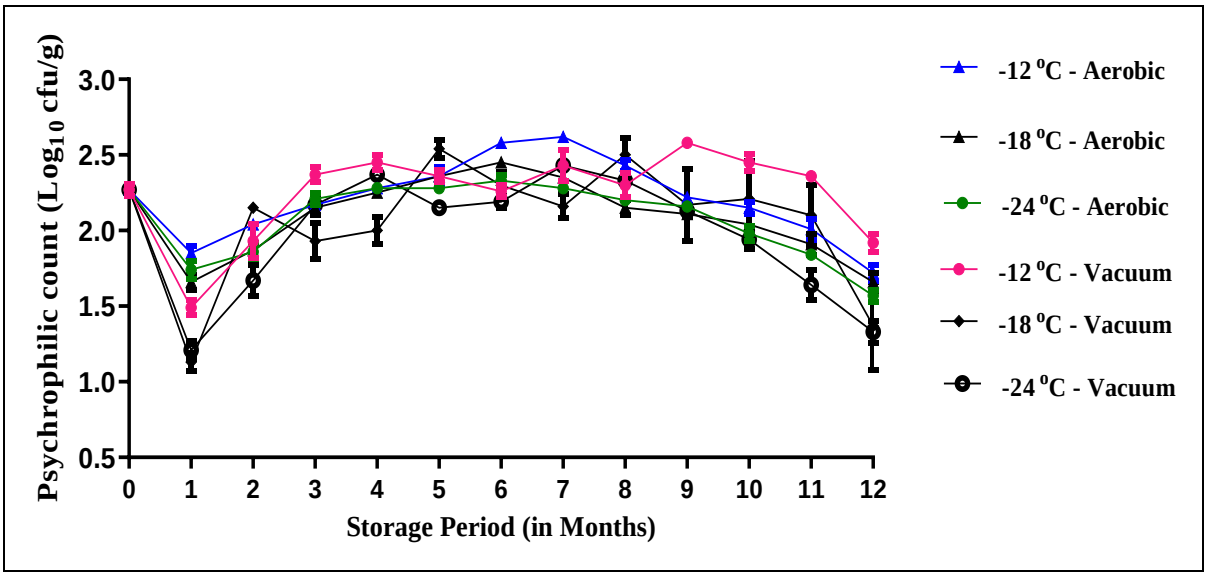

Fig 1: Changes observed in the Psychrophilic Count (log_{10} cfu/g) of aerobic and vacuum packed frozen broiler chicken under three different storage conditions (i.e. -12 °C, -18 °C and -24 °C)

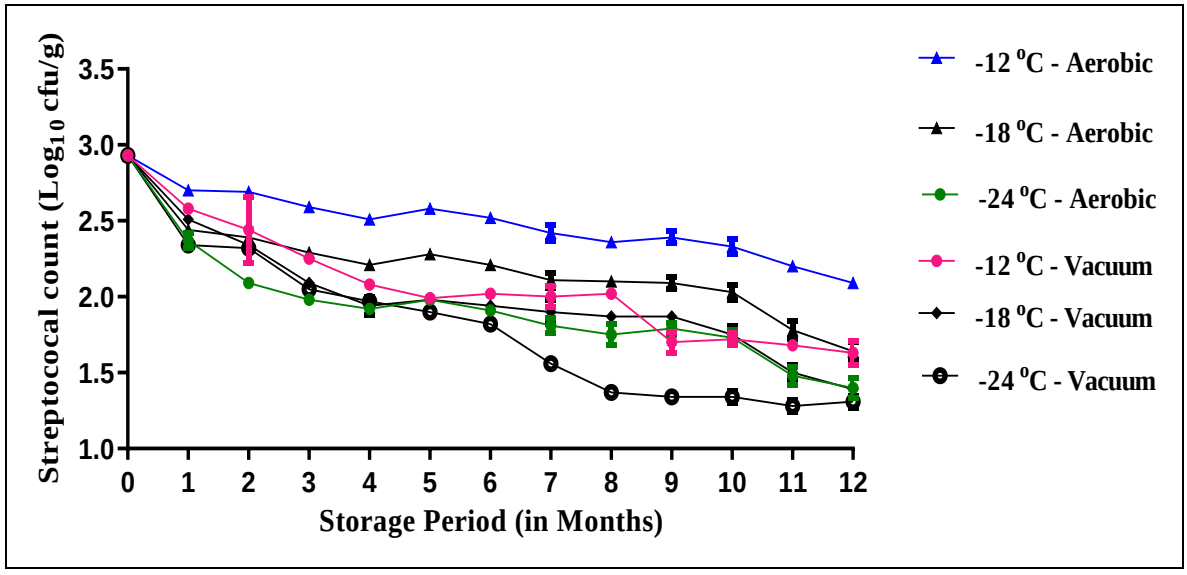

Fig 2: Changes observed in the Streptococcal count (log_{10} cfu /g) of aerobic and vacuum packed frozen broiler chicken under three different storage conditions (i.e. -12 °C, -18 °C and -24 °C)

Table 2: Changes observed in the Streptococcal count(log_{10} cfu /g) of aerobic and vacuum packed frozen broiler chicken Under three different storage conditions (i.e. -12 °C, -18 °C and -24 °C)

Storage Period	Aerobic Packaging			Vacuum Packaging			F Value
	Temperature of Storage						
	- 12 ºC	- 18 ºC	-24 ºC	-12 ºC	- 18 ºC	- 24 ºC	
0 Day (Before Freezing)	2.93 ± 0.02^{H}	2.93 ± 0.02^{G}	2.93 ± 0.02^{G}	2.93 ± 0.02^{F}	2.93 ± 0.02^{I}	2.93 ± 0.02^{H}	
1 Month	2.70 ± 0.02^{eG}	2.44 ± 0.02^{bcF}	2.37 ± 0.05^{aF}	2.58 ± 0.02^{dE}	2.51 ± 0.03^{cdH}	2.34 ± 0.02^{aG}	21.768**
2 Month	2.69 ± 0.02^{eFG}	2.39 ± 0.02^{cdF}	2.09 ± 0.02^{aE}	2.44 ± 0.22^{dD}	2.34 ± 0.02^{bG}	2.32 ± 0.02^{bG}	47.37**
3Month	2.59 ± 0.02^{dF}	2.29 ± 0.02^{cE}	1.98 ± 0.02^{aD}	2.25 ± 0.01^{cC}	2.09 ± 0.03^{bF}	2.05 ± 0.03^{bF}	104.362**
4Month	2.51 ± 0.03^{dDE}	2.21 ± 0.03^{cDE}	1.92 ± 0.03^{aCD}	2.08 ± 0.02^{bB}	1.94 ± 0.06^{aDE}	1.97 ± 0.03^{aE}	40.679**
5 Month	2.58 ± 0.02^{dF}	2.28 ± 0.02^{cE}	1.98 ± 0.02^{bD}	1.99 ± 0.02^{bB}	1.98 ± 0.02^{bE}	1.90 ± 0.02^{aDE}	183.053**
6 Month	2.52 ± 0.02^{eDE}	2.21 ± 0.02^{dDE}	1.91 ± 0.02^{bCD}	2.02 ± 0.03^{cB}	1.94 ± 0.02^{bDE}	1.82 ± 0.03^{aD}	124.09**
7 Month	2.42 ± 0.05^{eCD}	2.11 ± 0.05^{dCD}	1.81 ± 0.05^{bBC}	2.00 ± 0.07^{cdB}	1.90 ± 0.08^{bcDE}	1.56 ± 0.02^{aC}	39.607**
8 Month	2.36 ± 0.03^{eC}	2.10 ± 0.02^{dCD}	1.75 ± 0.07^{bB}	2.02 ± 0.03^{dB}	1.87 ± 0.02^{cD}	1.37 ± 0.03^{aB}	80.051**
9 Month	2.39 ± 0.04^{eC}	2.09 ± 0.04^{dC}	$1.79 \pm 0.04b^{cBC}$	1.70 ± 0.07^{bA}	1.87 ± 0.02^{cD}	1.34 ± 0.03^{aAB}	74.736**
10 Month	2.33 ± 0.05^{dC}	2.03 ± 0.05^{cC}	1.73 ± 0.05^{bB}	1.72 ± 0.04^{bA}	1.75 ± 0.06^{bC}	1.34 ± 0.04^{aAB}	42.265**
11 Month	2.20 ± 0.03^{dB}	1.78 ± 0.06^{cB}	1.48 ± 0.06^{bA}	1.68 ± 0.03^{cA}	1.50 ± 0.05^{bB}	1.28 ± 0.04^{aA}	44.481**
12 Month	2.09 ± 0.08^{cA}	1.64 ± 0.06^{bA}	1.40 ± 0.07^{aA}	1.63 ± 0.08^{bA}	1.39 ± 0.03^{aA}	1.31 ± 0.04^{aAB}	19.952**
Average	2.49 ± 0.02	2.19±0.03	1.94 ± 0.03	2.08 ± 0.03	2.00 ± 0.03	1.81 ± 0.04	
F Value	35.668**	72.234**	73.711**	86.7**	128.748**	302.636**	

*Mean±S.E. with different superscripts row wise (small alphabet) and column wise (capital alphabet) differ significantly. n =6 for each treatment. ** Highly significant ($P<0.01$).

Table 3: Changes observed in the Yeast and mould count (log_{10} cfu /g) of aerobic and vacuum packed frozen broiler chicken under three different storage conditions (i.e. -12 °C, -18 °C and -24 °C)

Storage Period	Aerobic Packaging			Vacuum Packaging			F Value
	Temperature of Storage						
	- 12 ºC	- 18 ºC	-24 ºC	-12 ºC	- 18 ºC	- 24 ºC	
0 Day (Before Freezing)	2.97 ± 0.03^{H}	2.97 ± 0.03^{I}	2.97 ± 0.03^{G}	2.97 ± 0.03^{G}	2.97 ± 0.03^{I}	2.97 ± 0.03^{G}	
1 Month	2.96 ± 0.03^{dH}	2.94 ± 0.02^{dI}	2.94 ± 0.01^{dG}	2.70 ± 0.01^{cF}	2.55 ± 0.01^{bH}	2.11 ± 0.02^{aF}	293.181**
2 Month	2.94 ± 0.02^{eG}	2.94 ± 0.01^{eI}	2.83 ± 0.01^{dFG}	2.73 ± 0.02^{cF}	2.55 ± 0.02^{bH}	1.95 ± 0.04^{aEF}	284.623**
3Month	2.97 ± 0.01^{dH}	2.92 ± 0.01^{dI}	2.71 ± 0.02^{cF}	2.69 ± 0.01^{cF}	2.42 ± 0.02^{bH}	1.81 ± 0.03^{aDE}	551.167**
4Month	2.92 ± 0.00^{dGH}	2.87 ± 0.01^{dHI}	2.58 ± 0.04^{cE}	2.62 ± 0.01^{cF}	2.26 ± 0.01^{bG}	1.92 ± 0.05^{aE}	200.262**
5 Month	2.88 ± 0.01^{eFGH}	2.79 ± 0.01^{dGH}	2.23 ± 0.04^{bD}	2.62 ± 0.01^{cF}	2.20 ± 0.01^{bFG}	1.74 ± 0.04^{aCD}	324.973**
6 Month	2.86 ± 0.00^{eFG}	2.72 ± 0.01^{dG}	1.77 ± 0.06^{bC}	2.67 ± 0.01^{dF}	2.09 ± 0.02^{cEF}	1.58 ± 0.06^{aC}	205.618**
7 Month	2.81 ± 0.01^{eF}	2.53 ± 0.02^{dF}	1.55 ± 0.11^{bB}	2.63 ± 0.02^{dF}	1.98 ± 0.01^{cDE}	1.36 ± 0.09^{aB}	94.552**
8 Month	2.55 ± 0.04^{dE}	2.11 ± 0.07^{cE}	1.36 ± 0.03^{aA}	2.48 ± 0.02^{dE}	1.89 ± 0.02^{bD}	1.35 ± 0.04^{aB}	103.701**
9 Month	2.14 ± 0.03^{eD}	1.92 ± 0.01^{dD}	1.24 ± 0.04^{aA}	2.29 ± 0.04^{fD}	1.76 ± 0.03^{cC}	1.35 ± 0.10^{bB}	141.626**
10 Month	1.90 ± 0.04^{dC}	1.67 ± 0.05^{bcC}	1.23 ± 0.06^{aA}	1.70 ± 0.06^{cC}	1.50 ± 0.08^{bB}	1.33 ± 0.09^{aB}	16.193**
11 Month	1.77 ± 0.04^{cB}	1.56 ± 0.09^{bcB}	1.20 ± 0.08^{aA}	1.41 ± 0.16^{bcB}	1.33 ± 0.12^{abA}	1.26 ± 0.09^{abB}	5.22**
12 Month	1.47 ± 0.05^{cA}	1.34 ± 0.02^{bcA}	1.20 ± 0.04^{abA}	1.28 ± 0.11^{bA}	1.21 ± 0.07^{abA}	1.05 ± 0.04^{aA}	5.578**
Average	2.55 ± 0.04	2.41 ± 0.05	1.99 ± 0.06	2.37 ± 0.04	2.05 ± 0.04	1.67 ± 0.04	
F Value	381.6**	236.436**	195.683**	130.306**	124.536**	68.884**	

*Mean±S.E. with different superscripts row wise (small alphabet) and column wise (capital alphabet) differ significantly. n =6 for each treatment.** Highly significant ($P<0.01$).

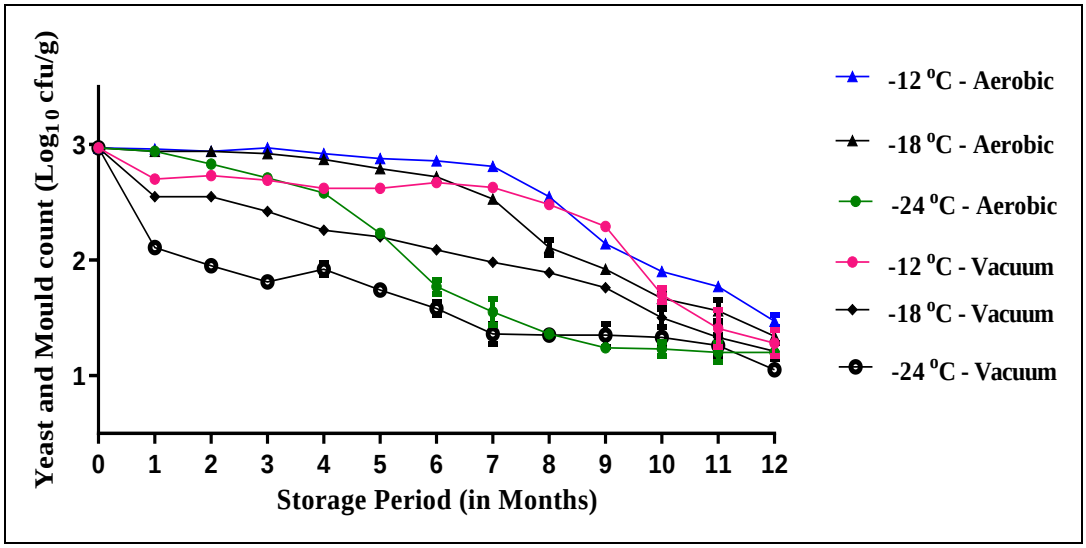

Fig 3: Changes observed in the Yeast and mould count (log_{10} cfu /g) of aerobic and vacuum packed frozen broiler chicken under three different storage conditions (i.e. -12°C, -18°C and -24°C)

Conclusion

From the above study on the microbiological qualities (psychrophilic count, Streptococcal count and yeast and mould count) of frozen broiler chicken meat samples packed under aerobic and vacuum condition with different storage conditions (-12 °C, -18 °C and -24 °C) had a significant decrease in the total count over a storage period of one year. Hence, this study reveals that the psychrophilic count, Streptococcal count and yeast and mould count in the aerobic packed broiler meat had a meagre increase in the count as compared to vacuum packed broiler meat samples. Hence, the study can conclude that the broiler chicken carcass can be frozen stored up to 12 months at -12 °C, -18 °C and -24 °C temperature without any microbial hazard and vacuum packaging of broiler chicken carcass is ideal for more extended storage concerning mentioned microbial counts.

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