

¹Department of Animal Science
Bangladesh Agricultural University,
Mymensingh-2202, Bangladesh

Research Article

Effect of freezing period on the quality of doe liver

BC Sharker¹, N Mia¹, MH Ali, MM Rahman¹, MA Hashem¹, M Khan^{1*}

*Corresponding author:

M Khan: muckta.khan@bau.edu.bd

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Abstract

The current study examined how the quality of doe liver was affected by a freezing period at -20°C . Raw, fresh doe liver was collected for this purpose and split into three treatment groups. On day 0, day 60, and day 120, they received treatment as T_1 , T_2 , and T_3 , respectively. Liver samples were frozen at (-20°C) and wrapped in plastic bags. For each treatment, the parameter studied were biochemical properties (TBARS), proximate component (DM, CP, EE, and Ash), physicochemical properties (pH, cooking loss, and water holding capacity), sensory attributes (color, taste, juiciness, and tenderness), and microbiological qualities (TCC, TVC, and TYMC). The findings demonstrated that as the number of storage days increased across all treatments, color, taste, juiciness, and tenderness all reduced ($p < 0.05$). DM content was significantly increase ($p < 0.05$), whereas crude protein, ether extract and ash were decreased with the increase of days of storage. pH and water holding capacity was decreased and cooking loss was increased among different treatments significantly ($p < 0.05$). Biochemical properties such as TBARS were increased significantly ($p < 0.05$). Microbial qualities such as TCC, TVC and TYMC values showed significantly ($p < 0.05$) higher value with the increase of days of storage. From these findings the nutritive value of doe liver is less decreased during 60 days storage so it is acceptable for human consumption but the third treatment as 120 days, its quality is deteriorated with the increase of storage time.

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Introduction

An essential edible postmortem component that comes from living animals that humans eat is meat and liver. The meat and liver are the most valued livestock product and is the primary choice of animal protein source for many people (Chakrabartty et al., 2024; Kawsar et al., 2006; Sarkar et al., 2008; Tsegay, 2015). Meat and liver refer to any animal meat that is consumed. The liver is an excellent source of protein, including glycoproteins, albumen, and globulin, according to several studies. Bangladesh's demand for meat and meat products has been rising quickly because of increased per capita income and urbanization. It goes without saying that, with their increasing income, people is now more concerned with the nutritional value and quality of food products than they are with their quantity. To preserve the quality and safety of meat and meat products, appropriate methods must be used. The major goals of meat preservation are to prevent microbiological deterioration and increase the meat's shelf life (Rahman et al., 2023; Lawrie and Ledward, 2006). Many meat preservation techniques have been developed in the modern era, with freezing being the most beneficial worldwide (Hashem et al., 2023; Sultana et al., 2008). The quality of meat products can be impacted by the complicated process of freezing, which includes heat transfer as well as several physical and chemical changes (Mia et al., 2023; Bing and Sun, 2002). It is preferable to avoid a noticeable temperature rise and increased food dehydration to ensure food quality at low temperatures. The rate of microbiological growth on the product surface will increase with the length of the thawing treatment period. Nutritional quality reduction due to leaching of soluble proteins, high energy consumption and large quantities of loaded wastewater are also other disadvantages of conventional methods (Roberts et al., 1998). In the meat industry, the utilization of slaughterhouse by products are highly focused on commercialization to reduce its environmental impact and cost management of the waste. Freezing commercially at -18°C and domestically at -10°C is now a standard of eating quality compared to fresh meat and -18°C to -20°C freezing temperature is effective for both preservations of meat and further manufacturing of meat (Farouk et al., 2004). The self-life of meat is normally determinate by assessing the color, microorganisms, pH value, flavor, texture, and nutritional value (Das et al., 2022; Hammad et al., 2019; McMillin, 2008; Sarker et al., 2021). At frozen temperature, some chemical and biochemical processes in the meat may still occur (Miah et al., 2024). They are mainly involving lipid oxidation and discoloration. These are responsible for the deterioration of meat quality during frozen storage (Turhan et al., 2017). Liver products are considered a high-risk food as these are highly nutritious and serve as an ideal medium for bacterial growth (Akhter et al., 2022; Karch et al., 2005; Yasmin et al., 2022). During the refreezing processes, moisture migrates from muscle cells to the space between cells (Charoenren, 2018). Freezing damage to the cell walls, leading purge to be released more easily from the meat and

moisture lost from the muscle cells not re-absorbed (Pham and Mawson, 1997). The freezing could also occur from the temperature fluctuation or abuse during storage, transportation, retail display and consumption (Wang et al., 1997). The repetitive melting and reformation of ice crystals generated by several freezing cycles damaged the cell membrane and altered the structural makeup of myofibrillar proteins, leading to the denaturation and aggregation of proteins as well as the loss of protein activity. These will have had an impact on the meat's texture and ability to hold water. Meats sold in retail stores should be of consistent quality and devoid of harmful fungus and germs that might injure people. To extend the shelf life of fresh meats, freezing or chilling is frequently used. Common techniques for safeguarding food include freezing and refrigeration, which stop the growth of microorganisms that might lead to food-borne diseases (Albrecht et al., 2019; Hammad et al., 2019). In Bangladesh, supermarkets now sell various meats and meat by-products kept at freezing temperatures to inhibit microbial growth. However, there is limited information on the shelf life of goat liver stored in these conditions. Therefore, the current study aims to: Examine the impact of storage duration on the sensory, nutritional, physicochemical, biochemical, and microbial quality of goat liver and determine the shelf life of doe liver stored at -20°C.

Materials and Methods:

Place of Experiment

The experiment was carried out in the laboratory of the Department of Animal Science at Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh

Experimental Samples

The experiment's doe liver was gathered from Machua Bazar in Mymensingh. The goats were transported to a convenient location and killed using the Halal technique. The sample was from a doe that was around two years old and weighed 12 ± 1 kg while she was alive. The doe liver sample was then promptly sent to the "Animal Science Laboratory" where it was subjected to microbiological, physicochemical, sensory, and proximate analyses.

Preparation of Jar and Other Instruments

All necessary instruments and jars or containers were cleaned with hot water and detergent powder and then dried properly before starting the experimental activities.

Preparation of doe liver sample

At first, 500 gm of fresh sample was taken for the preservation of doe liver. Then the doe liver sample was taken properly as per experimental design

Sensory Evaluation

Various sensory characteristics were looked at. Five trained panelists assessed each sample of goat liver. The sensory questionnaires assessed the following qualities: color, odor, juiciness, and tenderness, on a 5-point balanced semantic scale (weak to strong) (Hashem et al., 2023). The judges used the criteria to evaluate the samples. Students and department members were chosen as panelists, and they received training in compliance with American Meat Science Association requirements (AMSA, 1995). The sensory examination was done in separate booths with humidity, light, and temperature controls. Prior to sample evaluation, all panelists participated in orientation sessions to familiarize with the scale attributes (color, odor, juiciness and tenderness) of liver sample using an intensity scale. Sensory scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair and 1 for poor (Rahman, 2012). All samples were served in the Petri dishes. Sensory evaluation was accomplished.

Proximate Components

Proximate components such as Dry Matter (DM), Ether Extract (EE), Crude Protein (CP) and Ash were carried out according to the methods (AOAC, 1995). All determination was done in triplicate and the mean value was reported.

pH

Doe liver samples (5 g) were homogenized in 25 ml of distilled water using a grinder (SFM1500NM, Shinil Co. China) for 1 min. Sample solutions were centrifuged for 15 minutes at $2000 \times g$, and the pH was measured using a pH meter (Seven Easy pH, Mettler-Toledo GmbH, Switzerland).

Cooking loss

The liver samples were weighted (initial weight). Firstly, weighted liver was boiled at water bath to 100 for 30 minutes. After completed the boiling of liver samples secondary weight was measured. Then samples were prepared for measuring cooking loss.

The formula of cooking loss is:

$$\text{Cooking loss (\%)} = \frac{w_2 - w_3}{w_2} \times 100$$

Where, w_2 = liver weight before cooking

w_3 = liver weight after cooking.

Water holding capacity

The water holding capacity will be evaluated based on thawing drip loss, natural drip loss and cooking loss, forced drip loss by the Grau and Hamm method and the ability to bind added water by the centrifugal method described by Daszkiewicz et al. (2009).

The formula of water holding capacity is:

$$\text{Water holding capacity (\%)} = \frac{\text{Weight of sample after centrifugation}}{\text{Weight of sample before centrifugation}} \times 100$$

Biochemical analysis

The biochemical analyses were measured by these methods. Thiobarbituric Acid Value (TBARS). These methods of analysis are discussed below.

Thiobarbituric Acid Values (TBARS) (mg-MDA/kg)

Lipid oxidation was assessed in triplicate using the 2-thiobarbituric acid (TBA) method. 5 g samples were blended with 25 mL of 20% trichloro acetic acid solution (200 g/L of trichloro acetic acid in 135 mL/L phosphoric acid solution) in a homogenizer for 30 second. The homogenized sample was filtered with Whatman filter paper number 4, and 2 mL of the filtrate was added to 2 mL of 0.02 M aqueous TBA solution (3 g/L) in a test tube. The test tubes were incubated at 100°C for 30 min and cooled with tap water. The absorbance was measured at 532 nm using a UV-VIS spectrophotometer (UV- 1200, Shimadzu, Japan). The TBA value was expressed as mg malonaldehyde per kg of sample.

Microbial assessment

The microbial assessment of total viable count, total coliform count, and total yeast- mold count was undertaken. To determine these parameters, the procedures which were followed are described below:

Preparation of samples for TVC, TCC and Yeast-Mold count

Good grade doe liver was indicated by the first TVC value of 7.36 log CFU/g for fresh doe liver. Both in this investigation and in commercial operations, contamination from the environment (such as the air or food handlers) or from the survival of spores or resistant cells was a possibility. The sample could include some germs, but the circumstances of preservation limit how much of them can develop. The T1 of the three treatments was considerably ($p < 0.05$) lower than that of the other treatments. This product is best for the health of the customer, as indicated by its lower TVC score. TVC value rose during storage. Antioxidant molecules prevented fat from degrading and helped stop bacteria from metabolizing fat. With an extended storage duration came an increase in TVC.

Media and reagent employed for TVC, TCC and Yeast-Mold count

Solid media and reagents

Potato dextrose agar (PDA), MacConkey agar (MA), and plate count agar (PCA) were the media used for these bacteriological analyses. The commercial media were produced in compliance with the makers' instructions. The media preparation processes and its composition are explained. During the investigation, 0.1% peptone water was employed as the diluent. The ingredients and methods for making the diluent are described.

Glassware and other appliances

Different types of glassware and appliances were used during the experiment. These were as follows: Test tubes (with or without Durham's fermentation tube and stopper), petridishes, conical flask, pipette (1 ml, 5 ml, 10 ml and 25 ml capacities), glass rod spreader, test tube stands, mortar and pestle, whirly mixture machine, blender machine, water bath, incubator, refrigerator, sterilizing instruments, hot air oven, ice boxes, electronic balance, electronic pH meter etc.

Preparation of media

A quantity of 11.50 g of PCA agar and 15.6 g of MA agar were dissolved in 500 ml and 300 ml of cold distilled water in two separate conical flasks and heated to boiling for dissolving the ingredients completely. For PDA, 200 g of pre-peeled and sliced potatoes were cooked for an hour in 1000 ml of purified water. Following the boiling process, clean cheesecloth was used for sifting. The potato infusion solution was mixed with 20 g of commercial dextrose and 15 g of agar, and the mixture was brought to a boil to fully dissolve the components. The media were then autoclaved for 15 minutes at 121°C (6.795 kg pressure/sq. inch) to disinfect them. pH 7.0 \pm 0.1 was the end reaction's corrected value. It was then time to pour the agar. The medium was maintained in a 45°C boiling water bath before to pouring.

Enumeration of total viable count (TVC)

For the determination of total bacterial counts, 0.1 ml of each ten-fold dilution was transferred and spread on triplicate PCA agar using a sterile pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of the plate with a sterile glass spreader. For every plate, a single sterile spreader was utilized. After that, the plates were stored for 24 to 48 hours at 35°C in an incubator. Plates showing between 30 and 300 colonies were counted after incubation. A colony counter was used to count the colonies. To get the overall viable count, the dilution factor was multiplied by the average number of colonies in each dilution. The ISO (1995) method was used to obtain the total viable count. The overall bacterial count data were reported as colony forming units (CFU/g), or the number of organisms per gram of liver samples.

Enumeration of total coliform count (TCC)

Using a sterile pipette, 0.1 ml of each ten-fold dilution was transferred and disseminated over duplicate MA agar to determine the total coliform counts. Using a sterilized glass spreader, the diluted samples were distributed as soon as possible throughout the plate's surface. For every plate, a single sterile spreader was utilized. After that, the plates were stored for 24 to 48 hours at 35°C in an incubator. Plates showing between 30 and 300 colonies were counted after incubation. A colony counter was used to count the colonies. To get the overall coliform count, the dilution factor was multiplied by the average number of colonies in each dilution. The results of the total coliform count were expressed as the number of organism of colony forming units per gram (CFU/g) of liver samples.

Enumeration of Yeast-Mold count

Using a sterile pipette, 0.1 ml of each ten-fold dilution was transferred and disseminated on triplicate PDA agar to determine the counts of yeast and mold. Using a sterilized glass spreader, the diluted samples were distributed as soon as possible throughout the plate's surface. For every twenty plates, one sterile spreader was utilized. After that, the plates were stored for 48–72 hours at 25°C in an incubator. Plates showing between 30 and 300 colonies were counted after incubation. A colony counter was used to count the colonies. To get the yeast and mold count, the dilution factor was multiplied by the average number of colonies in a given dilution. The results of the yeast and mold count were expressed as the number of organism of colony forming units per gram (CFU/g) of liver samples.

Statistical Analysis

MSTAT-C was used to analyze the data in one way ANOVA as per completely Randomized Design (CDR). Means were considered significantly different ($P < 0.05$). Data presented are shown as means \pm SD (Standard deviation).

Results and Discussion:

Sensory Evaluation

There were six groups of samples and three treatments, prepared for the determination of sensory quality of doe liver. In first day, color, flavor, juiciness, and tenderness were determined from fresh liver and then rest of samples were freezing at -20°C . The parameters for sensory quality (color, odor, juiciness, and tenderness) have been shown in Table 1.

Table 1. Values of sensory parameters in fresh and freezing doe liver

Parameters	Treatments			Level of significance
	T ₁	T ₂	T ₃	
Color	5.00 ^a \pm 0.01	4.47 ^b \pm 0.10	3.83 ^{ab} \pm 0.11	$p < 0.05$
Flavor	5.00 ^a \pm 0.02	4.40 ^b \pm 0.15	3.85 ^c \pm 0.01	$P < 0.05$
Juiciness	5.00 ^a \pm 0.01	4.73 ^b \pm 0.41	3.91 ^{ab} \pm 0.06	$P < 0.05$
Tenderness	5.00 ^a \pm 0.02	4.67 ^b \pm 0.52	3.93 ^c \pm 0.25	$P < 0.05$

Here, T₁= Day 0, T₂= Day 60, T₃= Day 120, Means in each row having different letter vary significant at 5% level, $p < 0.05$. Values are presented as mean \pm SD.

Color

The result of color score of doe liver treatments are presented in Table 1. The range was 5 to 3.83 of overall observed of color score. In different treatments, color score of doe liver was significantly decreased ($p < 0.05$) with increasing days of storage.

In that treatments, most desirable color was observed in T₁, and less desirable color was observed in T₃ group. Gradually decreasing appearance and color score of doe liver. Most preferable color was observed from treatment one which is 0 days and other treatment was 60 and 120 days. It might be due to pigment and lipid oxidation, resulting in non-enzymatic browning between lipids and amino acids. Some authors reported that oxidation of myoglobin is responsible for browning of meat during storage (Khan et al., 2023). Georgantelis et al. (2007) presented that the oxidative browning of the meat product still occurred during frozen storage.

Flavor

The result of flavor score of doe liver treatments are presented in Table 1. The observation range was 5 to 3.85. Flavor score was significantly decreased ($p < 0.05$) with increase of freezing time. The most preferable flavor was observed from T₁ and the less preferable flavor from T₃. The lower flavor scores may be related to the increased of malonaldehyde formation due to oxidation of fat, which has detrimental effect on the flavor and firmness of the product (Hashem et al., 2022; Miller, 1980). Deterioration of flavor during storage might be due to microbial growth, formation of FFA and oxidative rancidity. It was stated that one of the common problems encountered during meat storage is the development of undesirable flavor characteristics due to oxidative changes.

Juiciness

The different treatments of juiciness score are shown in Table 1. The result of juiciness score range was 5 to 3.91. Juiciness scores were significantly decreased ($p < 0.05$) with the increase of storage time. Among the treatments most acceptable juiciness score was observed from T₁ and less acceptable score was observed from T₃. Hossain et al. (2021) reported that a decline in the juiciness scores of different meat products during frozen storage. Aaslyng et al. (2003) showed that the lower juiciness of frozen stored meat most likely resulted from the loss of water during thawing and cooking loss which was only slightly lower relative to fresh meat.

Tenderness

In Table 1, the result of tenderness score range at different treatment was 5 to 3.93. Tenderness scores were significantly decreased ($p < 0.05$) with the increase storage time. Among the three treatments, most acceptable tenderness was observed at T₁, and less acceptable tenderness observed at T₃. In frozen condition of doe liver, ice crystals form inside the cells of muscle tissue and puncture the cell walls. It is the causes of liver leak moisture when they were cooked. Tenderness is interrelated with dry matter content of liver. With the increasing of storage period dry matter was increased consequently, tenderness was decreased with day's intervals. The result of this experiment is also related to (Lui et al., 2010) findings. Several researchers have associated with tenderness of meat with the breakdown of myofibrillar proteins affected by the presence of calcium-dependent proteases or calpains (Muchenje et al., 2009). Further, similar findings were supported by Suhairah et al. 2016.

Proximate Analysis

There were six groups of samples for three treatments was prepared for the determination of proximate analysis of doe liver. In first day, DM, CP, EE, Ash was determined and then rest of samples were stored at -20°C and analyzed. The determined values of proximate components are shown in Table 2.

Table 2. Value of proximate components in fresh and freezing liver

Parameters	Treatments			Level of significance
	T ₁	T ₂	T ₃	
DM%	26.30 ^a ±0.64	26.83 ^b ±0.85	27.23 ^{ab} ±0.54	P<0.05
CP%	23.60 ^a ±0.27	23.53 ^b ±0.36	23.13 ^{ab} ±0.21	P<0.05
EE%	2.73 ^a ±0.08	2.21 ^b ±0.05	2.01 ^c ±0.05	P<0.05
Ash%	1.11 ^a ±0.22	0.83 ^b ±0.31	0.67 ^{ab} ±0.01	P<0.05

Here, T₁= Day 0, T₂= Day 60, T₃= Day 120. Means in each row having different letterary significant at 5% level, p<0.05. Values are presented as mean ± SD.

Dry Matter (DM)

The DM content of different treatments of doe liver are shown in Table 2. The overall observation range of DM content at different treatments was 26.30% to 27.23%. Different superscript was observed for three treatments of groups indicates there were significantly (p<0.05) differences of DM content. The highest amount of DM content indicates the product is less acceptable. The same trend was also observed by Konieczny et al. (2007) and they reported that DM content increased during frozen storage. A non-significant decrease in ash percentage was reported by Ziauddin et al. (1993) which coincided with this study.

Crude Protein (CP)

The CP content of different treatments of doe liver are shown in Table 2. The overall observation range of CP content at different treatments was 23.60% to 23.13%. The same superscript was observed for three treatments of groups indicates there were significantly (p<0.05) differences of CP content. The highest amount of CP content indicates this product is most acceptable for consumer's health observed from first day and less acceptable CP content was observed on third treatment. The CP content was decreased with the increased storage days. The same trend was also observed by Konieczny et al. (2007) and they reported that CP content decreased during frozen storage.

Ether Extract (EE)

The EE content of different treatments of doe liver are shown in Table 2. The overall observation range of EE content at different treatments was 2.73% to 2.01%. EE content was significantly (p<0.05) decreased among the observation. Among these three treatments most acceptable EE content was observed from T₁. The lowest amount of EE content was observed from T₃ treatments and this indicates that this product is less acceptable for consumer's health. Agnihotri (1988) reported deterioration in meat lipids took place due to intermediary activities of endogenous meat enzymes leading to hydrolysis of fat. The same trend was also observed by Konieczny et al. (2007) and they reported that Ether extract content decreased with the increase of storage days.

Ash

The ash content of different treatments of doe liver are shown in Table 2. The overall observation range of ash content at different treatments was 1.11% to 0.67%. Among these three treatments most acceptable ash content was found from T₁ and less acceptable found from T₃. The ash content was significantly decrease with the increased of storage time and the low amount of ash content indicates that this product is less acceptable for consumer's health. A non-significant decrease in ash percentage was reported by Ziauddin et al. (1993) which coincided with this study. The same trend was also observed by Konieczny et al. (2007) and they reported that ash content decreased with the increase of storage days.

Physicochemical properties

The physicochemical properties such as pH, cooking loss and water holding capacity were determined, and the results obtained are given in Table 3.

Table 3. Values of physicochemical properties in fresh and freezing temperature of doe liver

Parameters	Treatments			Level of significance
	T ₁	T ₂	T ₃	
pH	6.93 ^a ±0.12	6.72 ^b ±0.07	6.64 ^c ±0.09	P<0.05
Cooking Loss (%)	13.38 ^a ±0.24	18.96 ^b ±0.39	22.24 ^{ab} ±0.8	P<0.05
Water holding Capacity (%)	88.45 ^a ±0.02	88.31 ^b ±0.04	88.14 ^c ±0.03	p<0.05

Here, T₁= Day 0, T₂= Day 60, T₃= Day 120. Means in each row having different letterary significant at 5% level, p<0.05. Values are presented as mean ± SD.

pH

The pH of different treatments of doe liver with days' interval are given in Table 3. The overall observation of pH range at different treatments was 6.93 to 6.64. With the increase of freezing time pH value were significantly decreased (p<0.05). Among the three treatments observation, most acceptable pH value was from T₁, and less acceptable pH value was from T₃. In this treatment, the highest amount of pH indicates the product is most beneficial for consumer's health than other group of treatments. The data of the treatments showed a slight decrease in the pH values and an increase in the acidity values for all samples along with freezing cycle. The third treatment of doe liver, increase of free fatty acids due to

rancidity. The decreasing pH was probably due to the secretion of microorganisms in the doe liver. A similar result was reported by Ali et al. (1982) who examined the lamb meat.

Cooking loss

The cooking loss of different treatments of doe liver with days' interval are given in Table 3. The overall observation of cooking loss range at different treatments was 13.38% to 22.24%. With the increase of storage days, cooking loss were significantly increased ($p < 0.05$). Among the three treatments results, most acceptable cooking loss was observed at T_1 and less acceptable cooking loss observed at T_3 . In this treatment, the lowest amount of cooking loss indicates this product is most beneficial for consumer's health than other treatment groups. Cooking loss refers to the reduction in weight of liver during the cooking process (Jama et al., 2008; Muchenje et al., 2009). Such losses are lower following a rapid freezing compared with slow freezing. This is because of small crystallization formed by the rapid freezing (Hui, 2004). Cooking loss in liver is very important for maintaining an attractive retail display of goat liver. As an example, meat and their products are a good source of proteins, essential minerals, and vitamins. The increased loss such nutrients deteriorates the meat nutritional quality and lowers its purchase (Jama et al., 2008). The meat also tended to shrink during the cooking process due to the denaturation of meat protein; the loss of water and fat also contributed to the shrinking process (Serdaroglu et al., 2005). Cooking yield is an important data that are used by the meat industry to predict the behavior of their products during processing.

Water holding capacity

The WHC of different treatments of doe liver with days' interval are given in Table 3. The overall observation of WHC range at different treatments was 88.45 to 88.14. With the increase of freezing time WHC value were significantly decreased ($p < 0.05$)

Biochemical Properties

Biochemical properties indicate the good or bad quality of doe liver. The biochemical component Thiobarbituric Acid Value (TBARS mg-MA/kg) were determined, and the results are given in Table 4.

Table 4. Biochemical properties of doe liver at fresh and freezing temperature

Parameters	Treatments			Level of significance
	T_1	T_2	T_3	
TBARS (mg-MDA/kg)	0.29 ^a ±0.03	0.35 ^b ±0.03	0.41 ^{ab} ±0.01	$P < 0.05$

Here, T_1 = Day 0, T_2 = Day 60, T_3 = Day 120. Means in each row having different letter significant at 5% level, $p < 0.05$. Values are presented as mean ± SD.

Thiobarbituric Acid Value (TBARS)

TBARS of different treatments of doe liver with days' interval are given in Table 4. The overall observation of TBARS range at different treatments was 0.29 to 0.41. With the increase of storage time, TBARS were significantly increased ($p < 0.05$). Among the three treatments observation, most acceptable TBARS value was observed at T_1 and less acceptable TBARS value observed at T_3 . The lowest TBARS value results of the products indicate that the product is beneficial for human health. Similar results were reported for meat and meat products during frozen storage (Ganhao et al., 2011). Also, Similar phenomenon was observed in lamb meat by Ali et al. (1982).

Microbial assessments

This study observed the presence of micro-flora (TVC), TCC and TYMC on fresh and preserved samples. According to the Table 5. The initial value of TVC, TCC and TYMC for fresh doe liver were significantly lower compared to storage samples, indicating that all these values were increased with increase the storage days. The lower value indicates the freshness of product which is most preferable for consumers' health. Similarly, a study in beef stated that the mean value of TVC, TCC and TYMC for fresh sample is lower than preserved samples (Elhadi et al., 2016).

Table 5. Microbiological assessment of doe liver among different treatments at fresh and refreezing temperature

Parameter	Treatments			Level of significance
	T_1	T_2	T_3	
TCC (logCFU/g)	2.15 ^a ±0.05	2.36 ^b ±0.04	2.61 ^{ab} ±0.02	$p < 0.05$
TYMC (logCFU/g)	1.65 ^a ±0.01	1.73 ^b ±0.03	1.81 ^c ±0.02	$p < 0.05$
TVC (logCFU/g)	3.86 ^a ±0.05	4.11 ^b ±0.03	4.34 ^c ±0.02	$p < 0.05$

Here, T_1 = Day 0, T_2 = Day 60, T_3 = Day 120. Means in each row having different letter vary significant at 5% level, $p < 0.05$. Values are presented as mean ± SD.

Total Coliform Count (TCC)

Table 5 displays the TCC values for the various doe liver treatments at different time intervals. TCC ranged from 4.48 to 4.99 log CFU/g overall across all treatments. The TCC values rose considerably ($p < 0.05$) as the number of storage days increased. The observation of the three treatments showed that the most acceptable TCC value was at T_1 , and the least acceptable TCC value was at T_3 . Fresh doe liver had the lowest TCC value of all the goods; its starting value was 4.48 log CFU/g, indicating that the product is of high quality and favorable to human health. During storage TCC value was increased. The antioxidant compounds blocked the deteriorating of fat and helped for prevent the metabolism of fat by bacteria. The TCC was increased with the increased of storage period. As a result, bacterial growth was lower in doe liver at 1st day. Ab Aziz et al. (2020) Also, Similar phenomenon was observed in broiler chicken meat.

Total Yeast-Mould Count (TYMC)

Table 5 shows the TYMC values for several doe liver treatments with a days' gap. The TYMC range seen overall across treatments was 5.75 to 5.91 log CFU/g. The TYMC readings rose considerably ($p < 0.05$) as the number of storage days increased. The greatest acceptable TYMC value was found at treatment time T_1 , while the least acceptable TYMC value was found at treatment time T_3 . The fresh doe liver product had the lowest TYMC value values of all the items, with an initial value of 5.75 log CFU/g. This suggests that the product is of excellent quality and favorable to human health. The TYMC value rose as it was being stored. The flesh from broiler chickens also showed similar phenomena (Ab Aziz et al., 2020).

Total viable count (TVC)

The TVC values of different treatment levels are shown in Table 5. The range of overall observed aerobic plate count from the liver sample was 7.36 to 7.63 (log CFU/g) at different treatment levels. Fresh doe liver had an initial TVC value of 7.36 log CFU/g, which is indicative of high-quality liver. In this investigation as well as in commercial operations, contamination from the environment (i.e., the air or food handlers) or from spore or resistant cell survival was feasible. There could be some bacteria in the sample, but the storage environment limits how much of them can develop. The T_1 was considerably ($p < 0.05$) lower than all treatments among the three treatments. The lower TVC rating suggests that this product is best for the health of the user. TVC value grew as it was being stored. Antioxidant molecules helped stop fat from degrading and from being metabolized by bacteria. The longer the storage duration, the higher the TVC.

Conclusion

From the results of present study, it may be concluded that sensory, proximate component, physicochemical properties, biochemical and microbial quality of doe liver and up to sixty days is acceptable in terms of biochemical and microbial studies. In conclusion, raw doe liver freezing at (-20°C), the nutritional quality was acceptable up to 60 days but up to 120 days decreased the nutritional quality.

Conflict of interest

There are no conflicts of interest among the authors.

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