CHAPTER I: INTRODUCTION

If we simply define agriculture, it basically means raising crops and animals for human consumption. Bangladesh is an agricultural country where about 70% of its people live in rural area and 87% of them directly depend on agriculture for their livelihood (World Bank, 2016). One of the main component or structure of agriculture is livestock farming contributing to 1.44% of the Gross Domestic Products (GDP) in Bangladesh (DLS, 2022). Day by day, people of Bangladesh are getting interested in livestock farming. Goat is one of the most popular livestock species belonging to the family Bovidae which is widespread in tropical and sub-tropical regions. Between Asian nations, Bangladesh has the second highest number of goats with 60.60 million heads, 57% of all ruminant livestock (FAOSTAT, 2009). According to DLS, the population of goat in Bangladesh is 26.66 million in 2021-22 which has increased about 6.6% in the last 10 years (DLS, 2022).

Goat is known as poor man's cow due to the requirement of less investment money, less space, more disease resistance, provider of good quality meat, skin and milk. Goat farming are more advanced than that of crop enterprise because provide employment opportunities for family members (Chauhan et al., 1993). To improve the socioeconomic condition, both men and women are also involved with developmental activities and for rural women, goat rearing has been proved to contribute to their livelihood (Naher, 2000) and Alam, 2001). A current study revealed that by rearing Black Bengal Goat, women are increasing their income and improving their lifestyle at a rural community level (Faruque et al., 2016). In 2014, among the farm household, about 36%)people were involved in goat rearing (BBS, 2014). In Bangladesh, people are normally rearing goat in traditional backyard system, allowing them to graze in grazing land and tethered with short rope for morning to evening (Miah et al., 2005). However, commercial goat farming is also increasing day by day throughout the country.

With the rapid growing population throughout the world, the demand for meat is increasing. In 1961 to 2011, globally meat consumption increased per person per kilogram (kg) per year were 23.1 to 42.2 kg (Mazhangara et al., 2019). According to DLS 2015-17, in Bangladesh, about 257.66 lakh goat are contributed for total livestock

meat production which was 61.52 lakh metric ton at that year. Goat meat is appreciated because of its high protein content, characteristics flavour, low fat content (Murshed et al., 2014). In comparison to other meats such as beef, lamb, pork, the goat meat is healthier option. It is naturally lean, nutrient-dense and also offers a variety of health benefits. Goat meat has hypocholesteremic characteristics, more unsaturated fatty acid such as linoleic and oleic acid (Dawkins et al., 1999) and Mahan L.K et al., 1996).A study by (Malekian et al, 2014) found that chevon (raw) has 74.2-76% moisture,20.6-22.3% protein, 0.6%-2.6% fat, 1.1% ash. When compared to beef, pork, lamb, the meat chevon has less fat and less saturated fat (Mazhangara et al., 2019). Consumer find that goat meat is delicious and appealing according to sensory evaluation (Webb et al., 2005). Per 85g cooked per roasted chevon has protein 23 g, saturated fatty acid 0.79 g, 122 calories, fat 2.8 g, cholesterol 63.8 mg, Fe 3.2mg (Mazhangara et al., 2019). All type of people can consume goat meat because of no religious taboo (Ivanović et al., 2016).

From the ancient time, human has developed and practiced many techniques to preserve meat. The main purpose of preservation is to control the growth of microbes, unpleasant changes of meat, increase shelf-life and preserve the nutrient content of meat (Fennema & O.R., 1975). The oldest method of preserve the meat are smoking, drying and salting (Teixeira & Rodrigues, 2019). Heat application in food alter physical and chemical properties and influence on flavour, safety, nutrition value of food (Alizade et al., 2009). However, with the technological advantage, preservation of meat has taken a new edge. Chilling and freezing of meat are the widespread method of preservation now-a-days. Meat sellers and urban homemakers and most rural household use chilling and freezing method for short and long-term preservation (Faisal et al., 2009). According to USDA, Ground goat meat should be kept in the refrigerator for 1 or 2 days before cooking or freezing. Raw ground meat can be frozen and used within 3-4 months for best quality. Steaks, Raw roasts and chops can be put in freezer for 6-9 months (USDA, 2019). Frozen meat is safe but meat quality can be decreased due to long time storage. Long time storage of meat create color lose, lipid per oxidation and denaturation of protein (Gonçalves & Junior, 2009). Several authors reported that the quality of meat and meat products are damaged due to lipid peroxidation from frozen meat and meat products (Chatepa et al., 2021; Rey et al., 2001).

The presence of some carcinogenic product like radicals, hydroperoxide, aldehyde, epoxide at the time of freezing can also be found in meat and meat products (Balev et al., 2005). MDA is formed from hydrolysis of hydroperoxide which determine level of lipid oxidation (Almroth et al., 2005). MDA alter the taste of food and flavour (Mariutti & Bragagnolo, 2017); (Purrinos et al., 2011). Besides it helps to form atherosclerosis, cancer, act with DNA to form mutation (Cline et al., 2004).

Sometimes, in underdeveloped or developing countries, sellers preserve the meat for long time in super-shop and local market to avoid economic loss. Also, the abundance of meat during Eid-ul-Azha is stored for a significant amount of time in households. However, there have limited resources about the safe storage time of chevon at -20˚ C temperature. For those purpose, this study was conducted to detect the oxidative quality of fresh and frozen meat of goat collected from supershop and butcher shop.

Objectives:

1. To observe the safe storage time of chevon in freezing condition.
2. To compare the quality of fresh and frozen chevon.

CHAPTER II: MATERIALS AND METHODS

2.1 Study area:

The study was performed at Chattogram, Bangladesh. All the samples were collected from different locations of Chattogram Metropoliton area. The laboratory experiment was done at PG Laboratory under the department of Animal Science and Nutrition of Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram.

2.2 Collection and preservation of meat sample:

The sample was collected aseptically in the zipper bags from super shops and local slaughter house of Chawkbazar, Panchlaish, Mehedibag, Kotwali, Pahartoli and Akbar Shah. Immediately after collection, the sample was kept in ice box with cooling gel and transported to the laboratory as soon as possible. The collected samples were preserved in the freezer (-20˚ C) until use. The 1st set of meat sample was collected in December 2021 and stored for 8 months, the 2nd set in April, 2022 and stored for 4 months. Finally, before laboratory analysis, fresh meat samples were collected in July, 2022.

2.3 Determination of oxidative stability of meat:

Oxidative stability of meat was determined by estimating the thiobarbituric acid reactive substances (TBARS) using spectrophotometer. The determination method was adapted from (Ke et al., 1984). The TBARS value was estimated from the freshly collected or frozen goat meat samples at day 1, day 4, day 7 and day 10 that were stored at 4˚C. For estimating the TBARS, 4g of chevon sample were weighed by using digital balance (METTLER TOLEDO, Model: ML104T, Switzerland). Then 10ml of distilled water was added with the meat sample followed by 10 ml of solution 1 (Composed of Phosphoric acid, Trichloroacetic acid and distilled water). Then the mixture was homogenized by homogenizer (Model: OV5, VELP SCIENTIFICA, Italy) for at least 1 minute. After homogenization, the homogenate was filtered using Whatman filter paper number 1. After filtering, 2 ml of the filtrate was taken in a 15 ml falcon tube. Then 2 ml of solution 2 (4,6 dihydroxy-2-mercaptopyrimidine in distilled water) was added. The solutions were gently mixed and placed in hot water bath (Model:WB-22, Princial: Witeg Labortechnik GmbH, Germany) 80˚ C for 30 minutes. After that the tubes were removed from the water

bath and cooled down to room temperature. Then the absorbance of samples was measured by spectrophotometer (UV VIS Spectrophotometer, Model: UV-2600, Manufacturer: SHIMADZU, Country of origin: Japan) under the wavelength 530nm. The TBARS value was estimated from the absorbance by using formula. The value was expressed in micromoles of malondialdehyde (MDA) per 100g of meat.

2.4 Compilation of data: All the data were recorded and compiled using Microsoft Excel, 2019.

2.5 Statistical analysis: The analysis was done by using R studio version 4.2.1 (Team 2022). The level of statistical significance was accepted at 5%.

CHAPTER III: RESULTS

Chevon meat contains relatively higher amount of lipid compared to beef and carabeef. The amount of saturation may influence the keeping quality of meat. In this study, fresh and stored chevon were tested to measure the level of lipid oxidation of meat frozen for 4 and 8 months compared to fresh meat. The results in Table 1 show that at day 1, fresh meat had the lowest level of TBARS value which ranged from 0.45 to 0.83. The highest values were observed in meat frozen for 8 months where the range was from 0.60 to 3.75 µmol MDA per 100 g of meat. In meat frozen for 4 months the TBARS value were from 0.45 to 2.70 µmol MDA per 100 g of chevon. At 4^{th} day, the lowest TBARS value was 0.23 and highest was 3.08 in fresh meat sample. The lowest TBARS value was 2.10 and highest value was12.53 in meat stored for 4 months. For 8 months frozen chevon had the highest TBARS value was 15.45 and lowest was 1.73. At day 7 for fresh chevon the TBARS value range were 0.26 to 22.01. For 4 months chevon samples the TBARS value range were 11.89 to 49.61. And for 8 months storage chevon sample TBARS value range start from 2.06 to 25.54. At day 10, in all meat samples the value of lipid oxidation increased gradually up to 53.14 µmol MDA per 100 g of meat. In frozen chevon samples, the TBARS value were highest 66.41in chevon stored for 4 months and 99.11 µmol MDA in chevon stored for 8 months. It is observant from the result that in every step the fresh meat had minimum lipid oxidation level compared to chevon that were stored for 4 to 8 months. The TBARS values from fresh chevon stored to 4 months and 8 months chevon stored were significant ($p < 0.05$). The value of TBARS in chevon at day 1, 4, 7 and 10 differed significantly ($p < 0.001$). In Table 1. The TBARS values from fresh to 4 months and 8 months were significant.

Table 1: TBARS values for Fresh, 4 months and 8 months stored chevon sample

Meat Storage Time	Sample ID	TBARS Value (µmol MDA/ 100g)			
		Day 1	Day 4	Day 7	Day 10
Fresh	C1	0.83	0.75	7.99	12.79
	C2	0.60	0.83	1.09	26.21
	C3	0.45	0.23	0.26	34.31
	C4	0.60	3.08	22.01	42.19
	C5	0.83	1.28	2.14	53.14
4 Month	C6	1.13	3.30	11.89	16.09
	C7	1.20	3.75	20.89	48.26
	C8	1.43	12.53	14.59	36.86
	C9	0.45	2.10	49.61	65.51
	C10	2.70	8.70	31.54	66.41
8 Month	C11	3.08	15.45	22.76	99.11
	C12	2.25	5.03	18.49	66.41
	C13	3.75	9.60	25.54	35.21
	C14	0.60	2.03	16.69	49.61
	C15	2.03	1.73	2.06	30.19

	Df	**Sum Sq**	**Mean Sq**	**F Value**	**Pr (>F)**
Storage	2	1254	627	3.907	0.026 *
Day	3	18069	6023	37.519	3.06e-13 ***
Residuals	54	8669	161		

*Significant, *** Highly significant

The result of lipid oxidation in fresh and 4 and 8 months stored meat at day 1, 4, 7 and 10 at 4˚C is presented in Figure 1 where a significant ($p < 0.001$) trend of gradual increase in the values of TBARS is observed.

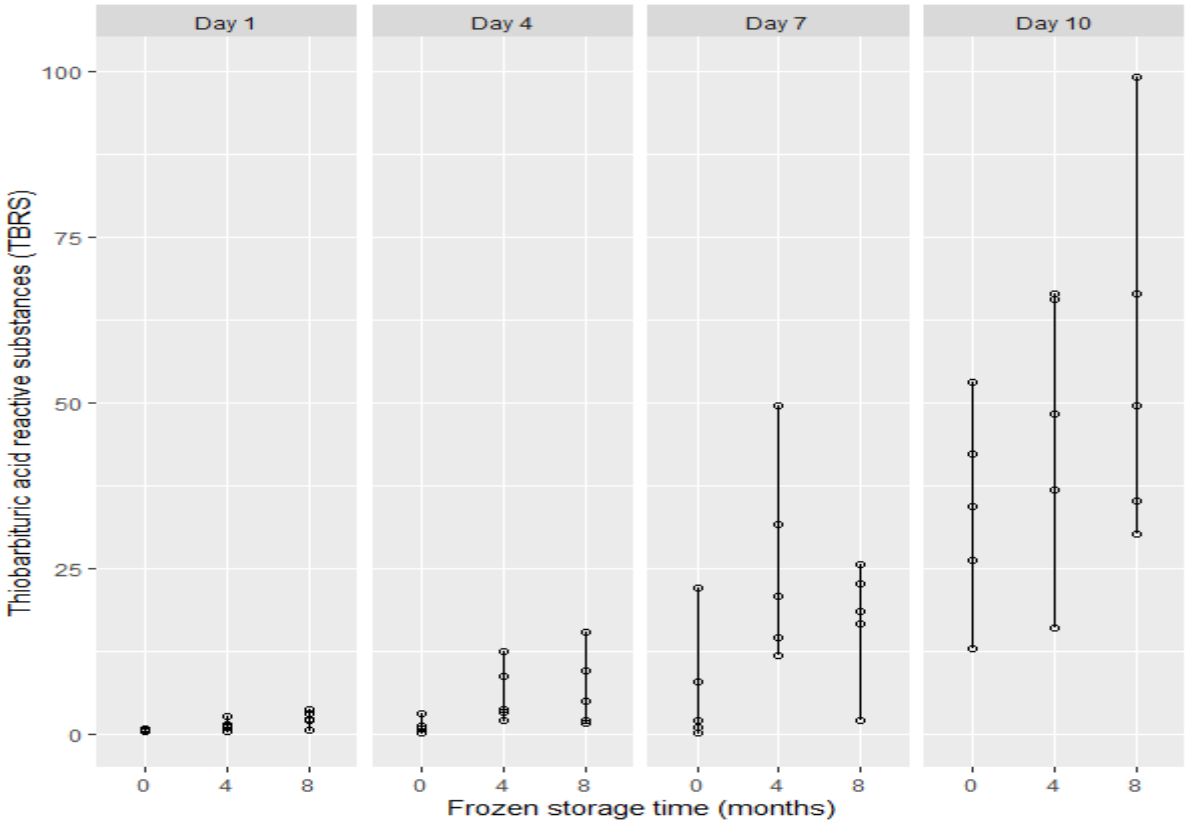

Figure 1: Line plot of TBRAS values found in four repeated tests for fresh and frozen meat samples

CHAPTER IV: DISCUSSION

Sample storage for 4 months and 8 months chevon had higher TBARS value compare to fresh sample were showed in Table 1. TBARS values were increased than fresh sample due to lipid per oxidation. As a result, form free radicals and oxidized the meat pigment then creates rancid odour and flavour (Faustman & Cassens, 1990). According to Błaszczyk et al., (2008), malondialdehyde (MDA), the primary lipid peroxide can indicate how much lipid peroxidation has occured. In this study, results showed that fresh chevon, 4 months stored chevon and 8 months stored chevon had significantly different TBARS values at day 1, 4, 7 and 10. Though meat is usually kept in the freezer for prolonged storage, the quality may deteriorate slowly over time. So, the chevon stored for 4 months had a comparatively lower lipid oxidation rate than chevon stored for 8 months. Usually, preservation time of raw chevon in the freezer is 6 to 9 months (USDA, 2019). Furthermore, according to FDA, the preservation of steak of fresh meat is 6 to 12 months but for chops, it is 4-6 months (FDA, 2018). In chevon meat without any supplement, at 0 day the TBARS values were 5 mg MDA/kg meat, at day 2 were 3.4 mg MDA/kg, at 4th day 4.5 mg MDA/kg, at day 6 were 5.5 mg MDA/kg (Garcia et al., 2019). Another experiment by Galipalli et al. (2004) observed that the TBARS value in control group of day 1 were 1.8mg MDA/kg, at day 3 was 3.6, at day 5 was 3.7 and at day 7 was 3.5 mg MDA/kg. A study by Widayaka et al. (2001) found that the TBA value of fresh raw chevon was 0.5 mg MDA/kg in 0 day which is 100 times lower than our findings. After 16 weeks of storage Ahmad et al. (2018) showed that TBARS value of chevon (Chunk, Mince) were 5.88± 0.01 and 5.91 ± 0.04 in meat from old female and in meat from young female TBARS value were 5.95 ± 0.03 and 5.92 ± 0.03 mg MDA/kg of meat. The goat meat stored at -18° c for 30 days had a TBARS value of 3.80 mg MDA/ kg of meat without any supplement (García et al., 2019). However, in this research, the collected meat samples were from different stores and sometimes the initial microbial load, improper handling, compromised personal hygiene and packaging may affect the TBARS value of fresh meat from market compared to the meats from research experiment. A previous study shows that the meat products packaged in edible films showed much lower values than the control on all storage intervals (Noor et al., 2018).

The difference among five samples from each group was observed. The differences in TBARS value may be due to the difference in diet, initial microbial load, storage condition in the market as meat was collected from both supershop and retail market. Also, different supplementations in diet can play a major roll in the TBARS value of chevon. For example, application of *Moringa oleifera* leaves in goat diet are improved oxidative stability of meat due to presence of polyphenol (k et al., 2013). Supplementation of *Astragalus membranaceus* in goat diet affected the lipid oxidation of chevon (Luo et al., 2020). TBARS value were decreased from 3.19, 4.01, 4.47 to 2.03, 3.53 and 1.71 mg MDA/kg of chevon when incorporated with 10% aqueous ginger, garlic and onion extract at 7 days storage but after 14 days values were increased (Chatepa et al., 2021). The TBARS value were increased due to supplement of linseed for 12 days (0.98 mg MDA/ kg) (Fusaro et al., 2022). In recent study, it was found that *Andrographis paniculata* can decrease the TBARS value in comparison to palm oil treatment (Karami et al., 2011). Dietery supplement of *Asparagus racemosus* and Alfa-alfa leaf on goat can improve oxidative stability (Gruffat et al., 2020); Kumaran & Citarasu, 2015);Sharma & Sahrawat, 2014). In this study, there was no available information about the diet and supplement of goats. The differences in collection places may also play important role in the TBARS content of fresh and frozen meat which may explain the differences in each sample in three groups.

Goat has much internal fat and less intramuscular fat than other ruminant (Lee & Kannan, 2012). Adipose tissue and number of fat content can modify the meat quality (Banskalieva et al., 2000). Fatty acid profile of goat can not depends on age and sex but pre-slaughter conditioning has impact on it which increase monounsaturated fatty acid and decrease total saturated fatty acid (Simela, 2007). In recent study, percentage of saturated fatty acid in Black Bengle goat was found 43-49% (Subhasish et al., 2018). Goat meat has higher unsaturated to saturated fatty acid ratio (Malekian et al., 2014). As unsaturated fatty acids are less stable than saturated fatty acids, meat with higher ratio of unsaturated fatty acid are prone to rancidity easily (Jacqueline, 2013). This may explain the deterioration in quality of chevon in frozen condition after 8 months.

CONCLUSION

Goat meat is one of the most popular types of food when comes to the choice of meat. The production of goat meat in Bangladesh is also influenced by the popularity of chevon. To preserve the meat properly and to maintain the quality, it is crucial to know the safe storage time. As the composition of chevon, high environmental temperature, lack of maintenance of slaughterhouse hygiene and improper control over food safety, meat can deteriorate before the expected time. It was observant that goat meat frozen for upto 4 months had slight change in lipid oxidation. However, chevon preserved for 8 months the meat quality were gradually degraded. It might be for initial loading of microbes, improper packaging, hygiene. This study will ensure the safe storage time of goat meat purchased from supershop and butchershop in the tropical environment Bangladesh.

LIMITATIONS

The study was conducted to check the oxidation stability of fresh, 4 months, 8 months chevon. However, the other parameters of meat quality were not detected due to the shortage of time. Also, no specific fund was provided which limited the sample size of the study. In future, related research can be performed using higher sample size along with other parameters of meat quality.

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Acknowledgements

First of all, I am grateful to the Almighty for giving me precious time and opportunity to complete this assignment.

It is with immense gratitude that I acknowledge my Supervisor DR. Kona Adhikary (Assistant Professor, Department of Animal Science and Nutrition, CVASU) for her great support and providing the facilities.

I also express deep appreciation to Dean and External Affairs for giving the chance to me to fulfill my study.

I would like to acknowledge the cooperation and support of all technical and non-technical stuffs of Department of Animal Science and Nutrition.

I am indebted to my family for their spontaneous blessings, support and encouragement that was needed for completion of my report.

I feel deeply honored in expressing my sincere thanks to Vice chancellor, CVASU, for allowing the opportunity of the study.

Most importantly I am very much thankful to Chittagong Veterinary and Animal Sciences University (CVASU) for giving me opportunity for my study.

Biography

The author, Badhan Chowdhury is a daughter of Amal Kanti Chowdhury and Sarmila Talukder. In 2014, she passed her Secondary School Certificate examination and got GPA 5 from Feni Government Girls High School, Feni. Then she passed Higher Secondary School Certificate examination in 2016 with GPA 5 from Feni Government College, Feni. At present she is an intern doctor under the faculty of veterinary medicine of Chattogram Veterinary and animal Sciences University, Khulshi, Chattogram. In future she would like to work as veterinary surgeon and has research interest on viral diseases with its degree of pathogenicity.