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### Original Paper

## Quality and chemical composition of meat recovered from bovine carcasses lightly infested with cysticercosis

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### ABSTRACT

Bovine cysticercosis is one of the zoonotic diseases caused by the larval form of *Taenia saginata*. The carcass, which is slightly affected by cysticercosis, must be conditionally approved after specific treatment or condemned if treatment is not available at the abattoir. In this study, 100 meat samples from normal carcasses and carcasses mildly affected by cysticercosis (50 samples each) were collected. The samples were analyzed for chemical composition and quality characteristics to compare normal meat with meat from cattle with cysticercosis. The protein, fat, and ash content of beef from animals slightly affected by cysticercosis revealed marginal changes compared to beef from normal carcasses. However, there was a significant increase in humidity as well as qualitative and quantitative changes in the amino acid profile and a reduction in the content of polyunsaturated fatty acids in the meat of cattle affected by cysticercosis. Meat from animals diagnosed with cysticercosis had TVB and TBA levels that were higher than normal but still within permissible bounds. In conclusion, meat from cattle suffering from mild cysticercosis is of lower quality and quantity than meat from animals in good condition. Further research is needed to study the effect of sex as a factor on the quality and chemical composition of meat recovered from bovine carcasses lightly infested with cysticercosis..

## 1. INTRODUCTION

Humans ingest protein-rich meals, primarily of animal origin, such as meat, to meet their nutritional needs (Maria and Mary, 2012). Due to its amino acid composition, meat is the most valuable source of high-quality protein. Meat is also a beneficial source of iron and certain vitamins. Therefore, eating meat can help prevent various nutritional deficiencies (Isam, 2014). One of the diseases that can affect beef quality is infestation by the larvae of the tapeworm *Taenia saginata* (Braae, 2018). In cattle, muscle stiffness, muscle wasting, and loss of condition resulted in poor-quality carcasses and the condemnation of heavily infested carcasses (El-Sayad et al., 2021).

Bovine cysticercosis is a zoonotic disease of cattle caused by the larval stage of *Cysticercus bovis* in the human intestinal cystode *Taenia saginata*. This disease dangerously affects human health because it is zoonotic and can be transmitted from animals to humans (Beyene and Hiko 2019). The economic losses caused by this disease adversely affect various factors (Rezende, 2018). The meat industry suffers the greatest loss because the infected meat has to be sorted out and is not suitable for human consumption (Jansen et al., 2018). Heavily affected carcasses must be completely sorted out, while lightly affected carcasses with cysticercosis must be approved under certain conditions. Storage at no more than 7 °C for three weeks renders the metacestode inactive (Gracey et al., 1999; Elkhtam et al., 2016).

To the best of our knowledge, this is the first study to examine the effects of cysticercosis on the chemical composition and quality of meat. The primary research

focuses on changes in the nutritional quality and quality characteristics of the meat.

## 2. MATERIAL AND METHODS

### 2.1. Sample collection

A total of 100 beef meat samples (100 g each from the *C. bovis* prediction site) were collected from Bassatin slaughterhouse, Cairo, Egypt. The samples were allowed to be taken out of the abattoir after permission from the Directorate of Veterinary Medicine, Cairo for further laboratory examination (50 normal and 50 diagnosed with mild cysticercosis). All samples were collected and immediately transferred to the laboratory in an ice box to the laboratory of food hygiene and control department. The comparison between normal and affected cattle meat with cysticercosis was carried out to estimate the difference in nutritional and chemical quality characteristics. Ethical approval number (BUFVM-21-12-2021).

### 2.2 Chemical composition

All samples were analyzed to determine their moisture, protein, fat, and ash content using the standard method recommended by the Association of Official Analytical Chemists (AOAC) (2005).

#### 2.2.1 Moisture % estimation (AOAC, 2005).

Two grams of the samples were put in a weighted steel dish and baked at 125 °C for two to four hours to measure the

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moisture percentage. The samples were powdered and thoroughly mixed. After 30 minutes, the samples were allowed to cool to ambient temperature. The samples were weighed repeatedly in the drying equipment until two consecutive, consistent weights were obtained. The water content percentage was estimated as per the equation (moisture percentage = [weight loss/weight of samples] x 100).

#### 2.2.2 Protein % estimation (AOAC, 2005).

For protein percentage estimation, two grams of samples were placed in a digestion flask and 50 g of K<sub>2</sub>SO<sub>4</sub>, 0.5 g of metallic mercury and 40 g of H<sub>2</sub>SO<sub>4</sub> were added. The flask was placed in an inclined position and heated gently until foaming stopped, then boiled for 30 minutes until the solution was clear, then cooled to below 25 °C and 200 mL of distilled water and 25 mL of sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) were added. In order to avoid pumping, 90 mL of 50% NaOH were added without shaking. The protein percentage was then computed using the equation  $\text{nitrogen\%} = \frac{[(\text{mL acid} \times \text{N acid}) - (\text{mL NaOH} \times \text{N NaOH})]}{(\text{weight of sample})} \times 1.4007$ , as follows:.

#### 2.2.3. Fat % estimation (AOAC, 2005).

Five grams of heat-dried samples were put in a Soxhlet extractor that was linked to the chiller in order to calculate the fat percentage. Petroleum ether was placed within a Soxhlet flask that was electrically heated and attached to the extractor. Following a 6-hour extraction, the petroleum ether was removed using a boiling water bath, and the flask was oven-dried for 30 minutes at 100 °C before being chilled in desiccators and weighed. The difference between the flask's pre- and post-extraction weights was then used to assess the fat content.

#### 2.2.4 Ash % estimation (AOAC, 2005).

A dry, clean, and weighed crucible containing five grams of sample was heated in a muffle furnace set to 550–600 °C for six to eight hours to quantify the amount of ash present. The samples were weighed after being gradually heated up, then cooled in desiccators. The ash content was calculated using the formula:  $\text{ash content} = \frac{[\text{remaining weight (g)}]}{[\text{weight of sample collected (g)}]} \times 100$ .

### 2.3. Quality attributes for meat samples

#### 2.3.1 pH determination

The pH of the meat samples was determined directly from their previously prepared homogenate using a digital pH meter (Jenway3510pH-meter, Cole-Parmer, Staffordshire, United Kingdom) (El-bahr et al., 2021).

#### 2.3.2 Total Volatile Base Nitrogen (TVBN) Determination

Total volatile basic nitrogen (TVBN) was determined in meat samples by the distillation method, according to ES: 63-9/2006. The sample was distilled from magnesium oxide under standard conditions and volatile bases were titrated with boric acid.

#### 2.3.3 Thiobarbituric Acid Value (TBA) determination

Thiobarbituric acid (TBA) value was determined in meat samples by the distillation method according to ES: 63-10/2006. The thiobarbituric acid value is expressed in

malonaldehyde, the main product of fat rancidity. The sample was distilled from the acid under standard conditions and then the absorbance of the sample versus the blank was measured at 538 nm.

### 2.4. Fatty acid and Amino acid profile analysis

With minor adjustments, the fatty acid profile analysis was carried out using the methodology outlined by El-Bahr et al., 2021. In a nutshell, tissue homogenate was created by homogenizing meat samples and centrifuging them at 4000 rpm for 15 minutes. The total lipids and cholesterol in the supernatant were then measured using commercial kits (Stanbio Laboratory Company; Boerne, TX 78202, USA). Meat samples were centrifuged at 1792 × g for 10 minutes after being vortexed for 2 minutes in a chloroform-methanol solution (2:1 v/v) to extract total lipids. Following the esterification procedure, hexane and a methanol-sulfuric acid mixture (95:5; v/v) were used to prepare fatty acid methyl esters (FAME) from the supernatant. Using a temperature gradient program with hydrogen as the carrier gas and a split model, the FAME hexane extract was injected into the gas chromatography (GC; Agilent Technologies 7890A, USA) fitted with an SP2330 column (30 mm, 0.32 mm, 0.2 m film thickness; Supelco Analytical, USA) and flame ionization detector. FAME peaks were found using Hewlett-Packard ChemStation software (Agilent Technologies Inc., USA) by contrasting them with the fatty acid standard's retention time (Cat. No. 24073, Sigma-Aldrich, USA) (El-Bahr et al., 2021; Salah et al., 2019). The amino acid composition of the representative samples was determined using an analyzer according to AOAC (1990).

### 2.5. Statistical analysis

The significance of differences between the chemical and quality attribute values of each sample was determined by analysis of variance (ANOVA) and a t-test using SPSS 20 (SPSS, USA). Differences were considered significant at the  $P < 0.05$  level.

## 3. RESULTS

The percentage of nutrient composition of normal meat compared to meat from cattle with cysticercosis is recorded in Table 1. Moisture, protein, fat, and ash mean were 73.94 %, 20.21%, 2.60%, and 3.1% of normal meat. However, meat from cattle with cysticercosis was 74.53%, 18.71%, 3.30% and 2.10%, respectively. It was found that the protein content of the meat of cattle with cysticercosis decreased significantly, which may be due to the chemical change. The results showed a difference in the percentages of the ingredients but were still suitable for human consumption. Comparing the pH values of normal meat and meat recovered from cattle with cysticercosis, normal meat showed an average pH of  $5.71 \pm 0.001$ , while meat recovered from cattle with cysticercosis recorded  $5.93 \pm 0.02$  (Table 1). The results illustrated significant ( $P < 0.05$ ) alterations in the pH value for meat recovered from cattle with cysticercosis. The results of this study revealed significant ( $P < 0.05$ ) changes in TVBN and TBA in the meat recovered from cattle with Cysticercosis (Figure 1). The meat recovered from cattle with cysticercosis showed higher TVBN (7.31 mg/100 g) than normal meat (3.56 mg/100 g). At the same time, TBA value also increased with the meat recovered from cattle with cysticercosis (0.23 mg/kg). In comparison, meat from healthy animals was 0.06 mg/kg (Figure 2).

Table 1: Chemical composition and quality attributes of meat recovered from normal healthy animals and animals with cysticercosis.

Parameters	Meat (Normal Animal)	Meat (cysticercosis Animal)
<b>Chemical composition</b>		
Moisture (%)	73.9 ± 4.3	74.5 ± 3.8
Protein (%)	20.2 ± 1.3	18.7 ± 1.5
Fat (%)	2.6 ± 0.2	3.3 ± 0.4
Ash (%)	3.0 ± 0.1	2.1 ± 0.1
<b>Quality attributes</b>		
pH	5.77 ± 0.01 <sup>b</sup>	5.93 ± 0.02 <sup>a</sup>
TVN (mg/100g)	3.56 ± 0.13 <sup>b</sup>	7.31 ± 0.18 <sup>a</sup>
TBA (mg/Kg)	0.06 ± 0.01 <sup>b</sup>	0.23 ± 0.1 <sup>a</sup>

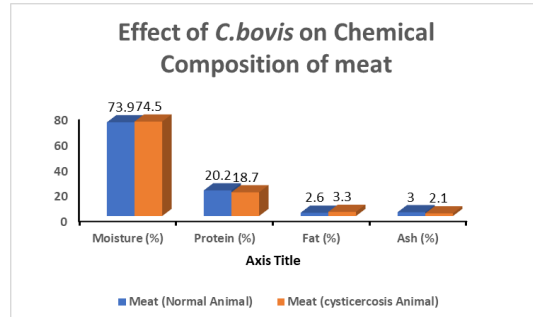


Figure 1: Chemical composition of meat recovered from normal healthy animals and animals with cysticercosis

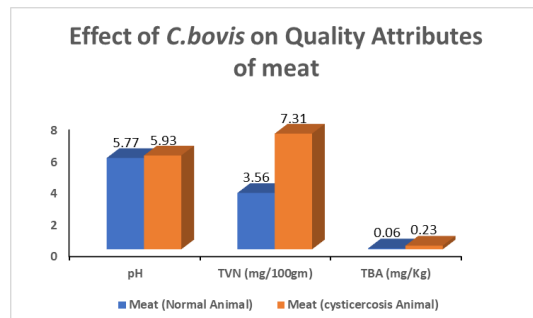


Figure 2: Quality attributes of meat recovered from normal healthy animals and animals with cysticercosis

The difference between the fatty acid fractionation percentage of normal and meat recovered from cattle with cysticercosis is illustrated in Figure 3. The total saturated fatty acids (SFA) were 46.3% and 47.1%, and the total monounsaturated fatty acids (MUFA) were 42.9 and 24.2%. At the same time, total polyunsaturated fatty acids (PUFA) were 27.1% and 25.8% for normal and meat recovered from cattle with cysticercosis. The amino acid fractionation percentage alteration between normal and meat recovered from cattle with cysticercosis is illustrated in Figure 4. Total essential amino acids (EAAs) were found to be 25.6% and 49.4%, respectively. In comparison, the total non-essential amino acids (NEAAs) were 46.3% and 48.5% for normal and meat recovered from cattle with cysticercosis.

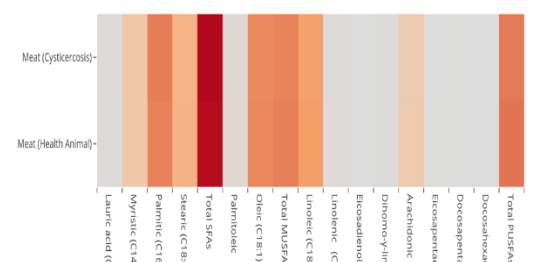


Figure 3: Fatty acids profile heat map for meat recovered from normal healthy animals and animals with cysticercosis.

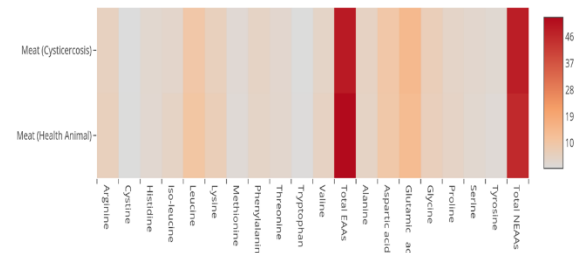


Figure 4: Amino acids profile heat map for meat recovered from normal healthy animals and animals with cysticercosis.

#### 4. DISCUSSION

About 72.75% of meat is made up of water, 21% nitrogenous compounds (19% proteins and 1.5% non-protein nitrogenous compounds, such as nucleotides, peptides, creatine, and creatinine), 2.55% lipids, 1% non-nitrogenous compounds (vitamins), carbohydrates, and 1% ash. (Kauffman 2012). The current study's findings demonstrated variations in the proportions of components that were nonetheless safe for ingestion by humans and did not deviate noticeably from the typical composition of meat. Meat's pH can decrease due to glycogen breaking down to produce lactic acid, whereas partial proteolysis, which results in an increase in free alkaline groups, can cause an increase in pH. (Pearson and Gillette 1996). The possible cause of the observed variance in pH values among the beef meat samples under examination is the impact of cysticercosis infection, which resulted in a chemical alteration in the meat's composition. Meat should generally have a pH of no more than 6.4; if it does, it should be deemed inappropriate for human eating. (Gracey and Collins 1992). In this study, the pH remained within acceptable limits but should be consumed quickly.

Meat from animals with cysticercosis showed a significant increase in TVBN for the meat spoilage marker. This was somewhat consistent with findings published by Alaa et al. (2021), who concluded that meat contamination from various sources renders meat unfit for consumption and that TVBN content rises with meat storage time. All of the beef samples that were tested, nevertheless, were deemed safe for ingestion. Their TVBN content was within the Abou-Youssef (2010) permitted level (not exceeding 20 mg%). One of the most deteriorating byproducts of rotten meat is ammonia. Total volatile basic nitrogen is one way to quantify it and serves as an indicator of the degradation of amino acids by bacteria. All of the samples that were examined had rancidity indicator results that were within the allowable limits (not exceeding 0.9 mg/kg), which were in line with the limits published by the Egyptian Standard (2005). Hassan and Omama (2011) may also be a helpful quality index for determining the degree of rancidity when storing foods high in fat. Furthermore, the TBA test is a sensitive test for the spoilage of meat that has a high level of undetectable unsaturated fatty acids. This implies that the TBA level rises with increasing meat fat content, suggesting probable lipid oxidation (Wilson, 1991). Finally, the TBA value is routinely used as an index of lipid oxidation in meat and rancid taste is first detected in meat when TBA values are between 0.5 and 2.0 mg/kg Habbal (2000)). The results for the fatty acid and amino acid profiles of meat indicated a negligible difference between meat from animals with cysticercosis and meat from healthy animals. This difference is within the normal range for these profiles and has little bearing on how much meat is consumed by humans.

## 5. CONCLUSIONS

The biochemical and qualitative characteristics of meat are altered when animals have cysticercosis; these changes are not always negative and may have an impact on the meat's biological value. The current study's findings imply that muscle tissue from healthy animals has a higher biological quality and is of higher quality than meat from calves afflicted with cysticercosis.

## 6. REFERENCES

1. Abou-Youssef, H. M. E. 2010. Quality assurance of camel's meat. M.V.Sc. Fac. Vet. Med. Alexandria University
2. Alaa, E.B.; Benjamin, W.B.; Stephen, G.G. and David, L. 2021. Total volatile basic nitrogen (TVB-N) and its role in meat spoilage. Trends in Food Science & Technology. V.109:280-302.
3. AOAC "Association of Official Analytical Chemists" 2005. Official methods of analysis. 14th Ed., w. Horwitz .w, (Editor), Academic Press, Washington, DC, USA.
4. Beyene, T. and Hiko, A. 2019. Zoonotic metacestodes and associated financial loss from cattle slaughtered at Yabello Municipal Abattoir, Borana-Oromia, Ethiopia. Parasite Epidemiol. Control, 5(1): e00096.
5. Braae, U.C.; Thomas, L.F.; Robertson, L.J.; Dermauw, V.; Dorny, P.; Willingham, A.L.; Saratsis, A. and Devleeschauwer, B. 2018. Epidemiology of *Taenia saginata* taeniosis/cysticercosis: A systematic review of the distribution in the Americas. Parasit. Vectors, 11,1: 1-12.
6. ES "Egyptian Organization for Standardization", 2006. Methods of analysis and testing for meat. Part 9: determination of total volatile nitrogen (TVN).ES:63-9/2006.
7. ES "Egyptian Organization for Standardization", 2006. Methods of analysis and testing for meat. Part 10: determination of Thiobarbituric acid (TBA). ES: 63-10/2006.
8. ES "Egyptian Organization for Standardization", 2005. Egyptian Organization for specialization and quality control, Egyptian Standard for fresh meat. Ministry of Industry No. 1522/2005.
9. El-Bahr, S.M., Shousha, S., Khatatb, W., Shehab, A., El-Garhy, O., El-Garhy, H., Mohamed, S., Ahmed-Farid, O., Hamad, A., Sabike, I., 2021. Impact of dietary betaine and metabolizable energy levels on profiles of proteins and lipids, bioenergetics, peroxidation and quality of meat in Japanese quail. Animals 11, 1–16. <https://doi.org/10.3390/ani11010117>
10. El-Sayad MH, Farag H, El-Taweel H, Fadly R, Salama N, Ahmed AA, Abd El-Latif NF 2021. *Cysticercus bovis* in cattle slaughtered in North Egypt: Overestimation by the visual inspection method, Veterinary World, 14,1: 155-160.
11. Elkhtam, A.O., Mostafa, I.A. and Shawish, R.R. 2016. Prevalence and economic impact of *Cysticercus bovis* in slaughtered cattle in Menofia province, Egypt. Alexand. J. Vet. Sci., 50,1: 130-134.
12. Gracey, J. F. and Collins, D. S. 1992. Meat Hygiene. 9th Ed., Baillier, Tindall, England. 415–599
13. Gracey, J.; Collins, D.S. and Huey, R. 1999. Diseases caused by helminth and arthropod parasites. In: Meat hygiene, 10th edn. WB Saunders, UK, 635–699.
14. Habbal, E. L. Y. 2000. Study on the quality control of some frozen meat products. M.V.Sc. Thesis. Fac. Agric. Cairo Univ.
15. Hassan, A. A. and Omama, A. 2011. Chemical evaluation of meat and meat products. Assuit Vet. Med. J., 57,130:62-71
16. Isam T. K. 2014. Chemical contaminants of meat and meat products threaten human health. Proceedings of the 5th Annual Conference-Agricultural and Veterinary Research; February 2014; Khartoum, Sudan. 1634–1698.
17. Jansen, F.; Dorny, P.; Trevisan, C.; Dermauw, V.; Laranjo-González, M.; Allepuz, A.; Dupuy, C.; Krit, M.; Gabriël, S. and Devleeschauwer, B. 2018. Economic impact of bovine cysticercosis and taeniosis caused by *Taenia saginata* in Belgium. Parasit. Vectors, 11,1: 1-10.
18. Kauffman, R.G. 2012. Meat composition. In: Hui YH (ed) Handbook of meat and meat processing. CRC Press, Boca Raton, pp 45–61
19. Maria C., Mary T. 2012. Public Health-Methodology, Environmental and Systems Issues. London, UK: IntechOpen; 2012. Chemical residues in animal food products: an issue of public health. 30-45.
20. Perry, B. and Grace, D. 2009. The impacts of livestock diseases and their control on growth and development processes that are pro-poor. Philos. Trans. R. Soc. B. Biol. Sci., 364, 1530: 2643-2655.
21. Rezende, MTN; Komatsu, R.S.; Andrade, R.B.; Reis, S.L.B.; Leite, C.R.; Rocha, S.R.; Saut, JPE and Guimaraes, E.C. 2018. Economic losses due to the occurrence of cysticercosis in cattle from cities located in Minas Gerais, Brazil. Ciênc. Rural, 48,12: 10-16.
22. Salah, A.S., Ahmed-Farid, O.A., El-Tarabany, M.S., 2019. Carcass yields, muscle amino acid and fatty acid profiles, and antioxidant indices of broilers supplemented with synbiotic and/or organic acids. J. Anim. Physiol. Anim. Nutr. (Berl). 103, 41–52. <https://doi.org/10.1111/jpn.12994>
23. Shalash, F. A. 1989. Quality evaluation of sheep carcasses slaughtered at Kalyobia abattoirs. Assuit Vet. Med. J., 46, 91:150- 159.
24. Wilson, A. 1991. Practical meat inspection, 5th Ed, Blackwell, Scientific Publication, Oxford. UK.