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Proximate analysis of hoof capsule in buffaloes

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Abstract
The proximate analysis of the hoof of buffalo was carried out to assess the biochemical properties. The study revealed that buffalo hoof contained 14.78±0.38 percentage moisture. The crude protein (CP) content on dry matter basis was 88.04±0.08 percentage, total ash on dry matter basis was 1.84±0.03 percentage, crude fiber (CF) on dry matter basis was 0.79±0.01 percentage, ether extract (EE) on dry matter basis was 0.88±0.02 percentage and nitrogen free extract (NFE) on dry matter basis was 8.45±0.04 percentage. The findings about the biochemical composition of buffalo hooves will form a strong anatomical foundation on the structure of hoof of these animals, which can be used for extrapolations and further investigations in the same species or for comparative analysis, including cattle and horses. Another positive aspect was the possibility of associating the dry material, mineral matter, organic matter, crude protein and ester extract with the strength of the digits that bear the greater portion of the animal's body weight and the impact when the hooves touch the ground.

Keywords: buffalo hoof, proximate analysis, biochemical composition

Introduction
Hoof serves as an interface between the animal and its environment. It is exposed, internally to the influences of the metabolic products and externally to the impact of mechanical, chemical and biological agents from the environment (Webster,2001) [1]. Generally, nutrition is believed to play an important role in the occurrence of laminitis and it has been suggested that the acidic pH of rumen contributes to the pathogenesis (Cook *et al.*,2004, Nordlund *et al.*, 2004) [2-3]. Lameness is one of the most significant challenges for dairy industry because of its obvious disruption of animal welfare and severe economic losses to the farmers (Barker *et al*., 2010, Espejo *et al.*, 2006, Von Keiserlingk *et al*., 2012) [4-6]. The dairy cattle are more susceptible to various hoof diseases. Buffaloes are considered to be more resistant to hoof ailments compared to crossbred dairy cattle. Basic studies aimed at gaining a better understanding of the morphology and cellular and biochemical composition of the hoof of buffaloes are scanty and therefore deserving the attention of researchers.

Materials and Methods
Biochemical analysis on the hoof of buffalo was undertaken in the present work. Hooves of six adult she buffaloes collected from the animals slaughtered at Meat Technology Unit, Mannuthy formed the materials for the present study. Once the slaughter procedure was completed, the hooves were separated from the carcass by cutting at the level of carpal joint in forelimb and at the level of tarsal joint in himdlimb. After collection the hooves were thoroughly cleaned to remove the dirt and dung particles.

Moisture content
A hot air oven was used to determine the moisture content of the samples. Two samples of 2g each were processed according to ASTM D1576-90 and the average moisture content was determined using the formula (ASTM, 2001) [7]:

$$\text{Moisture content} = W1 - W2 / W1 * 100$$

Where
W1 = Original mass of sample (g) and
W2 = Oven dry mass of sample (g).

Crude Protein and Fat Content
Samples of the feathers were taken and dried to constant mass at 90 to 95 °C for 24 h. Total nitrogen and fat content of the dry matter were determined using two samples for each analysis (Holub *et al.*, 1988) [8]. Total nitrogen was measured by a micromethod (Conway, 1957) [9] and fat by 24 h petroleum-ether extraction in a Soxhlet apparatus (Montemurro and Stevenson, 1960) [10]. Protein content was further calculated according to Kjeldahl method.

Total Ash
Ash is the inorganic residue obtained after combustion of biomass and is an approximate measure of the mineral salts and inorganic matter in feathers. The ash content was calculated in relation to the dry weight of the original sample after overnight ignition of the sample at 575±25ºC.

Crude Fibre
Crude fibre is considered as a mixture of largely undigestible substances of vegetable origin obtained as the residue of a precisely defined digestion procedure using acetic, nitric and trichloro-acetic acids (AACC, 2000) [11].

Results and discussion
The proximate analysis of the hoof of buffalo revealed that it contained 14.78±0.38 percentage moisture. The crude protein (CP) content on dry matter basis was 88.04±0.08 percentage, total ash on dry matter basis was 1.84±0.03 percentage, crude fiber (CF) on dry matter basis was

0.79±0.01 percentage, ether extract (EE) on dry matter basis was 0.88±0.02 percentage and nitrogen free extract (NFE) on dry matter basis was 8.45±0.04 percentage (Table 1). The buffalo hoof is made up of 98.16 percentage organic matter and 1.84 percentage inorganic matter. Crude protein component is maximum since keratin is the major component of buffalo hoof. Amino acid analyses of hooves of cattle indicated differences in their composition related to dietary changes or to management (Hidiroglou and Williams, 1986) [12].

Table 1: Biochemical analysis and quantification of the Moisture content, crude protein, Total Ash, crude fibre, ester extract and carbohydrate found in the hoof capsule of buffaloes.

S. No.	Components	Composition (Mean±SD)
01	Moisture Content (%)	14.78±0.38
02	Crude Protein (% Dry Matter)	88.04±0.08
03	Total Ash (% Dry Matter)	1.84±0.03
04	Crude Fibre (% Dry Matter)	0.79±0.01
05	Ether Extract (% Dry Matter)	0.88±0.02
06	NFE (% Dry Matter)	8.45±0.04

Tomlinson *et al.,* (2004) [13] reported that the regulation and control of differentiation and nutrient flow to the epidermal cells play a central role in determining the quality and, consequently, the functional integrity of hoof horn. Decreasing nutrient supply to keratinizing epidermal cells leads to horn production of inferior quality and increased susceptibility to chemical, physical, or microbial damage from the environment.

Assis *et al.,* (2017) [14] reported that the buffalo hoof capsule contained 85.55% Dry Matter,0.73% Mineral Matter, 99.23% Organic Matter, 91.67% Crude Protein and 0.87%Ether Extract. The highest contents of mineral elements were concentrated in the digits that bear the greater portion of the animal's weight, suggesting that there is a positive relationship between these parameters and the strength and growth of the hoof capsule of the digits.He also reported that copper is an important mineral to ensure the strength of the hoof capsule, and that its concentration may result in better hoof quality. The biochemical analysis reveals that in the buffalo hoof contains concentrations of Cu where as in cattle hoof does not. Thus, as buffaloes are considered a species resistant to foot diseases and the biochemical parameters analysed can guide other studies, particularly those involving cattle breeds that are more susceptible to diseases of the digits.

Detailed investigation in to the mineral and amino acid composition of hoof of Indian buffaloes are required to correlate it with feeding and management practices and resistance to hoof ailments. The incidence of foot diseases in buffaloes is very minimal or they are considered to be more resistant to hoof ailments. Understanding the cellular and biochemical events involved in the formation and composition of hoof capsule and evaluating the microstructure of the capsule in buffalo may represent an innovation in bovine podology research.

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