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Assessment of fatty acid and mineral profile of Barbari kid in *longissimus lumborum* muscle and edible byproducts

Pramila Umaraw[a,*], V. Pathak[a], V. Rajkumar[b], Arun K. Verma[b], V.P. Singh[a], Akhilesh K. Verma[c]

[a] U.P Pt. Deen Dayal Upadhyay Veterinary Research and Go Anusandhan Sansthan, Mathura, U.P., India
[b] Central Institute for Research on Goats (CIRG), Makhdoom, Mathura, U.P., India
[c] College of Veterinary Science and Animal Husbandry, GADVASU, Ludhiana, Punjab, India

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ABSTRACT

Edible byproducts or organ meats of Barbari kids (*Capra hircus*) were analyzed for their fatty acid and mineral profile. Mineral profile analysis revealed significant ($P < 0.05$) difference between muscle and organ meat. Kidney had highest sodium content (202.39 mg/100 g) whereas potassium content was greatest in testicles (362.61 mg/100 g). Copper, iron and zinc were found to be highest in liver (6.97 mg/100 g), spleen (31.16 mg/100 g) and muscle (4.15 mg/100 g) respectively. Different categories of fatty acids i.e., saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids and ratio of PUFA/SFA, n6/n3 etc were also estimated. Spleen evinced the highest saturated fatty acid content (54.95%) although monounsaturated fatty acid content was greatest in muscle (40.36%). Polyunsaturated fatty acids were highest in liver (22.54%). PUFA/SFA ratio of liver (0.49) was similar to the recommended level whereas, spleen, brain and testicles showed favorable n6/n3 ratio.

1. Introduction

Meat production in world is anticipated to increase with a growth rate of 1.6% of which approximately 80% is expected to be produced by the developing countries by 2022 (OECD FAO Agricultural Outlook report 2013–2022). According to FAO (2011) world population will be consuming two-third more animal protein by 2050 than it does today. This tremendous increase in meat production would inevitably generate a much larger bulk of slaughter by-products. Slaughter by-products may constitute up to 66.0, 52.0 and 68.0% of the live weight of cattle, pigs and lambs respectively (Liu, 2008). These by-products includes organs, fat or lard, skin, feet, abdominal and intestinal contents, bone and blood. Edible by-products yield from these animals range from 20 to 30% of the live weight. Meat processing industries are still in infancy in most of the developing countries and the edible byproducts harvesting is negligible resulting into their disposal which itself is a costly affair and leads to loss of revenue. It is well known and documented that properly utilized offals can offset the cost of live animal. Better utilization of by-products would lead to a safer and cleaner environment overcoming the allegations of environmental pollution. Thus for the profitability and sustainability of the meat industry it is essential to utilize each and every part of the animal so that without increasing the number of animals, production and revenue may increase.

Meat and meat products are concentrated sources of high quality protein and their amino acid composition usually compensates for shortcomings of staple foods. They supply easily absorbed iron and assist in absorption of iron and zinc from other foods. These are also a rich source of vitamin B complex. Livestock contributes to around 12.9% of global calories and 27.9% of protein directly through meat, milk, eggs and offal besides contributing to agriculture in form of manure and land cultivation (FAO, 2009). Livestock products supply around 12.9% of calories consumed worldwide and 20.3% in developed countries (FAO, 2009). Being nutritionally rich meat consumption can alleviate common nutritional deficiencies. Livestock can increase the world's edible protein balance by converting protein found in forage that is inedible to humans into forms digestible by humans. Edible byproducts such as various organs can be a cheap source of animal proteins and can play an important role in processing and ready-to-eat product formulations. The various aspects of product development with incorporation of edible byproducts or organ meat has been studied by some of the workers like Maiti and Ahlawat (2011), Verma et al. (2007) and Toldrá et al. (2012).

* Corresponding author.
E-mail addresses: pramila1303@gmail.com, prmakh090412@rediffmail.com (P. Umaraw).

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Thus the present study was conducted to provide baseline information on the nutritional quality of goat edible by-products or organ meat. The study was directed towards analysis of fatty acid and mineral profile as they play a critical role in various lifestyles and deficiency diseases threatening the major proportion of world population.

2. Materials and methods

2.1. Source of raw materials

Work was conducted at Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, DUVASU, Mathura and at Goat Products Technology Laboratory, Central Institute for Research on Goats (CIRG), Makhdoom, Mathura, U.P. India. Ten male weaner Barbari kids each of 5–7 months of age were used for study. They were reared in Barbari experiment unit at CIRG under routine conditions like grazing plus concentrate supplementation. These animals were allowed to graze or browse 8 h daily in the grazing land of CIRG and concentrate mixture containing crude protein (CP) 14%, total digestible nitrogen (TDN) 60% was provided at the rate of 2% of body weight. All kids had free access to clean drinking water twice daily, once in the morning before taking animals out for grazing/feed offer and once in the afternoon, on their return from grazing area. Goats were slaughtered as per the standard procedure at the experimental slaughterhouse of Goat Products Technology (GPT) laboratory of CIRG, after 16–18 h fasting with ad-libitum supply of water. Carcasses were dressed as per the standard procedure. Dressed carcasses were weighed within 1 h (hot carcass weight) and organs-liver, kidney, heart, spleen, brain and testicles were hygienically collected and weighed within 30 min. A part of *longissimus lumborum* (*LL*) muscle from loin cut (high value) was also collected and stored for further study as a reference in experimental studies. All the collected samples were immediately shifted to LDPE film pouches, (sterilized by exposing to U.V. light for 30 min before use) of 250 gauge thickness of natural colour and stored at −18 °C for further study. All the chemicals used in the study were of analytical grade and were procured from Hi Media laboratories (P) Ltd., Mumbai and glass wares from Borosil Ltd. (New Delhi, India).

2.2. Mineral profile analysis

The samples for mineral analysis were digested as per the procedure described by Kolmer et al. (1951) with slight modification. Briefly, 1 g sample was mixed with 15 ml of Triple acid (HNO_3:H_2SO_4:HCl, 3:1:1 v:v) in 50 ml beaker. These samples were then kept as such overnight at room temperature. Next day the samples were digested slowly at low heat (less than 90° C) on a micro-digestion bench. When white fumes emanating from the samples stopped giving a clear solution and finally 1 ml volume was left the samples were removed from digestion bench. After cooling triple distilled water was added to digested samples and final volume was made upto 25 ml. The digested samples were then analyzed on Atomic Absorption Spectrophotometer (AAS 400 PerkinElmer, USA) for copper (Cu), Iron (Fe), and Zinc (Zn) estimation, while Sodium (Na) and Potassium (K) were estimated by a Flame Photometer.

2.3. Fatty acid profile

A direct and simple method of O'Fallon et al. (2007) was followed for preparation of fatty acid methyl esters (FAME) of organ meats. Briefly, 1.0 g finely chopped organ pieces were placed into a 16 × 125 mm screw-cap Pyrex culture tube to which 1.0 ml of the C13:0 internal standard (0.5 mg of C13:0/ml of methanol), 0.7 ml of 10 N KOH in water, and 5.3 ml of methanol were added. The pyrex culture tubes were incubated in a 55 °C water bath for 1.5 h with vigorous hand-shaking for 5 s every 20 min to properly permeate, dissolve and hydrolyze the sample. After cooling below room temperature in a cold tap water bath, 0.58 ml of 24 N H_2SO_4 in water was added. The tubes were mixed by inversion and with precipitated K_2SO_4 they were again incubated in water bath maintained at 55 °C for 1.5 h with hand-shaking for 5 s every 20 min interval. After FAME synthesis, tubes were cooled in a cold tap water bath. Three milliliters of hexane was added, and the tubes were vortex-mixed for 5 min on a multitube vortex. The tubes were centrifuged for 5 min in a centrifuge at 2500 rpm (Biofuge Primo R, Heraeus, Germany) and the hexane layer, containing the FAME, was placed into a Gas Chromatography (GC) vial and was kept at −20 °C until GC analysis. The fatty acid composition of the FAME was determined by capillary GC on a CP-6173, 60 m × 0.25 mm × 0.20 mm capillary column (Varian) installed on a Thermo Scientific Ceres 800 plus gas chromatograph fitted with Automatic sampler AI3000, integrator and flame ionization detector. The initial oven temperature was 120 °C, with a holding time of 5 min, subsequently temperature was increased to 240 °C at a rate of 2 °Cmin^{-1}, and was maintained there for 60 min. Nitrogen was used as the carrier gas at a flow rate of 1 ml/min. Both the injector and the detector were set at 260 °C. The split ratio was 30:1. Fatty acids were identified by comparing their retention time with the fatty acid methyl standards and were expressed as percentage of total fatty acids.

2.4. Statistical analysis

The data obtained in the study for various parameters were statistically analyzed on 'SPSS-19.0' software package as per standard methods of Snedecor and Cochran (1994). For each parameter duplicate samples were drawn which were run thrice ($n = 60$). Data obtained was subjected to one way analysis of variance, homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between samples.

3. Results and discussion

3.1. Mineral profile analysis

The results of mineral analysis have been evinced in the form of mean and standard error in Table 1. There was a significant difference ($P < 0.05$) between mineral content of muscle and organ meat. Substantial differences were observed in mean concentrations of sodium, potassium, copper, iron and zinc in all the organs contemplated. The mean mineral concentrations (mg/100 g) in *LL* muscle for sodium, potassium, copper, iron, and zinc were similar to the values reported by Casey et al. (2003) The mineral composition of tissues depends on various factors, such as concentration of minerals in feed, age, sex, health status, developmental stage and physiological characteristics of the organ. Variations in mineral composition can also be due to differences in the type of tissue, sampling process, production system and seasonal changes (Tajik et al., 2010).

Sodium mean concentration varied significantly ($P < 0.05$) among all the organs where kidney revealed highest concentration followed by testicles. The possible reason behind this finding might be the physiological function of osmoregulation performed by kidney to maintain the homeostasis. The mean sodium content of liver was similar to those reported in buffalo liver (60 mg%), veal liver (678.3 mg/kg), goat muscle (64.48 mg/100 g), and beef skeletal muscle (Devatkal et al., 2004; Florek et al., 2012; Casey et al., 2003; USDA, 2011). While the values were lower than beef liver (81–136 mg/100 g), porcine liver (82.2 mg/100 g) and camel