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Armando Bau Mau Afonso
Faculty of Agriculture, Animal Science Department, National University of Timor Lorosa'e. Dili, Timor-Leste

Cesar C Sevilla
Ph.D., Chair of Advisory Committee and Professor, Institute of Animal Science, University of the Philippines, Los Baños, College, Laguna, Philippines

Amado A Angeles
Ph.D., Member of Advisory Committee, Institute Animal Science, University of the Philippines, Los Baños, College, Laguna, Philippines

Jose A N Bautista
Ph.D., Member of Advisory Committee, Institute of Animal Science Cluster, University of the Philippines, Los Baños, College, Laguna, Philippines

Josefina T Dizon
Ph.D., Member of Advisory Committee, College of Public Affairs and Development, University of the Philippines, Los Baños, College, Laguna, Philippines

Corresponding Author:
Armando Bau Mau Afonso
Faculty of Agriculture, Animal Science Department, National University of Timor Lorosa'e. Dili, Timor-Leste

Changes in carcass and meat quality of male crossbred kids pre-weaning stage fed different sources of raw milk, cow milk replacers and soybean milk

Armando Bau Mau Afonso, Cesar C Sevilla, Amado A Angeles, Jose A N Bautista and Josefina T Dizon

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Abstract
An experiment was conducted to determine the effects of feeding raw milk from goat, cattle, buffalo, commercial cow milk replacers and 50% soybean milk + 50% goat milk on carcass and meat quality of male crossbred kids. The male crossbred kids were randomly allotted into five treatments with each treatment group consisting of six replicates. The five dietary treatments were as follows: T1- Goat Milk, T2 - Cow Milk, T3 - Buffalo Milk, T4 - Milk Replacer and T5 – 50% Soybean Milk + 50% Goat Milk. Dietary treatments were imposed on Day 5 and weaned on Day 60. After weaning, male crossbred kids were fed conventional diet of 20% concentrate, and 80% Para grass (*Brachiaria mutica*). Two male crossbred kids per treatment were sacrificed for carcass and meat quality analysis. Prior to slaughter, the animals were fasted overnight. Standard slaughtering procedures of goats were followed. Results reveal differences in carcass dressing percentage of kids at pre-weaning stage were probably due to the differences in body weight. Dressing percentage increases as the animal advances in age and maturity. No significant differences were observed on the fore and hind quarter carcass yield. Furthermore, the results of the study showed differences on chemical quality of meat. Those differences were on water content, crude fat and ash. Results indicate that providing milk replacer as an alternative to goat milk in kid rearing increases the marketable milk yield and farm profitability without any negative effects on kids' growth and performance.

Keywords: Carcass, meat quality, raw milk, cow milk, soybean milk

Introduction

Goats (*Capra hircus*) are small ruminants which have been widely reared by livestock farmers. Goats like cattle are easy to raise, do not need a large area to be reared and do not require high quality of feed.

Meat, milk and hide. Goats are also used as holistic tools for land vegetation management and fire fuel load control. With proper grazing management, goats can eliminate noxious weeds, restore native grasses and prevent fires through fuel load reduction. Moreover, goat meat is the most heavily consumed red meat in the world.

Goat meat is an important source of income and food for rural populations in developing countries as well. In 2008, approximately 97% of the world's total goat meat is produced in these countries (FAOSTAT, 2008) [9]. Globally, there is increasing interest in goat-meat production for agricultural diversification and meeting the requirements for healthier meat by health-conscious respondents (McLean Meyinsse, 2003) [16]. In 2000, around 3.7 million metric tons of goat meat was produced worldwide. This represents only 1.6 percent of the total world meat production, which is at 233 million metric tons (FAO, 2001) [8]. Yet, this amount of goat meat production does not clearly reflect the actual level of production; a high proportion is either sold to consumers directly at the farm gate and consequently does not follow proper marketing channels, or is consumed in the home and therefore not marketed at all.

Different kid rearing systems can be applied in order to provide the maximum marketable milk yield during the suckling period and thus to increase farm profitability. Kid rearing with milk replacer (MR) is one of these systems and plays an important role, especially for large flocks (Keskin and Biçer, 2002) [14]. Various liquid feed sources nourish the kids after feeding first colostrum and transition milk.

Milk replacers are very good sources of liquid feed for kids. Appropriate and ample supply of nutrients for kids through liquid feed (whole milk and milk replacer) is essential for performance and welfare. Due of the digestive limitations of kids less than three weeks of age, ingredients formulation is critical to allow for adequate digestion, proper growth and performance. Therefore, milk replacers must be formulated with ingredients processed for the underdeveloped digestive system of the young kids (Bugti *et al*., 2016) [7].

In kid rising, whole milk is excellent for use in feeding kids but should be limited to daily feeding of approximately 10 percent of body weight. According to Muehlhoff *et al*. (2013) [18], milk contains numerous nutrients and makes a significant contribution to meeting the body's needs for calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (vitamin B5).

According to Stubbs and Abud (2002) [26] cow's milk or quality milk powder/replacer is suitable for kids. While, milk replacers are widely used to feed new borne goat kids with the objective to market the dam milk and kids may be provided more nutritious feed for better growth and development (Bugti *et al*., 2016) [7]. Milk replacers are substitutes for milk, having characteristics such as the physical form, texture, taste and nutrient content closely resembling whole milk. Calves, lambs and kids of less than three weeks of age should preferably be on milk replacer made of all milk protein (Krishnamoorthy and Moran, 2011) [15]. Bugti *et al*. (2016) [7] concluded that milk replacer can be used to feed goat kids.

Very minimum attention has been paid to the incorporation of plant protein sources in substantial amounts in milk replacers for ruminant kids as compared to formulas for calves (Ouédrago *et al*., 1998) [19]. Soybean is a source of high quality, relatively inexpensive protein that has potential for use in milk replacer (Ghorbani *et al*., 2007) [11]. Sarker *et al*. (2015) [21] reported that neonatal goat kids may be reared artificially by replacing whole milk with soy milk up to 50 percent without any detrimental effects on their performance.

Generally, the study aims to determine the effects of different milk sources, cow milk replacer, soybean milk and 50% soybean milk + 50% goat milk on carcass and meat quality of male crossbred kids

Materials and Methods

The study was conducted at the Institute of Animal Science (IAS), College of Agriculture and Food Science, UPLB, College, Laguna, Philippines from March to October, 2017.

Treatments

The male crossbred kids were randomly allotted into five treatments with each treatment group consisting of six replicates. The five dietary treatments were as follows: T1- Goat Milk, T2 - Cow Milk, T3 - Buffalo Milk, T4 – Cow Milk Replacers and T5 – 50% Soybean Milk + 50% Goat Milk.

Pre-weaning management

Dietary treatments were imposed on Day 5. The male crossbred kids assigned to treatments other than goat milk were given an adjustment period of four days. The adjustment period involved a combination of decreasing volume of goat milk and increasing volume of the dietary treatments to prevent digestive disorder. The male crossbred kids were bottle-fed twice a day at 800 and 1600 hr for 68 days or a feeding period of 60 days. The amount of liquid dietary treatments was given at the rate of 10% of the body weight and adjusted every two weeks.

On Day 15 of the trial, all male crossbred kids were initially offered with small amount of concentrate and fresh grass twice a day in equal amount in all groups and water was supplied *ad-libitum*. A salt mineral block was made available to all crossbred kids. The daily intake of both concentrate and forage was measured starting at day 45 of treatment. Training the crossbred kids to eat concentrate and forage early in life prepared them for weaning from the liquid diet at Day 60.

After weaning from liquid diets at day 68, the remaining animals were shifted to conventional diet of 20% concentrate, and 80% para grass (*Brachiaria mutica*). The ration was offered to satisfy the dry matter requirement of 3.5% of male crossbred kids body weight. The concentrate was formulated to contain 16% crude protein and 80% total digestible nutrients with composition of rice bran (10.03%), copra meal (10.00%), yellow corn (44.58%), soybean meal (6.81%), wheat pollard hard (26.40%), and limestone grain (1.56%), salt (0.35%) and include micro-minerals). The nutrient contents of the concentrate were DM (88.40%), CP (16%), Fat (5.45%), ADF %), Ash (4.45%) and TDN (80%). The post-weaning feeding period lasted for another 60 days. Salt-mineral block and drinking water were made available at all times.

Data gathering procedures

Two male crossbred kids per treatment were sacrificed for rumen characteristics as well as for carcass and meat quality analysis. Another two male crossbred kids per treatment were sacrificed for same study after post-weaning stage. Prior to slaughter, the animals were fasted overnight. The standard procedures for slaughtering of goats were followed. By this method, goats were bled by cutting the throat and then slaughtered by severing the head at its connection on the occipito-atlantal space. At the time of sacrifice, blood was collected in a pail and the weight was recorded. The head was removed along with the pelt and feet and each weighed individually. Liver, kidney, spleen, lung, with trachea and heart were separated from attached tissue and weighed separately.

The whole digestive tract was removed immediately and the rumen, reticulum, omasum and abomasum with and without contents were weighed.

Hot carcass weight (HCW) was recorded immediately after completing dressing and evisceration. The carcass was then chilled for 24 h at 4 ◦C. The hot carcass weight (HCW) was recorded immediately after dressing. After the cooling period, chilled carcass weight (CCW) was recorded and the carcass was split along the midline. The left side of the carcass was ribbed between the 12th and 13th rib interface to determine fore part percentage and divided into four primal cuts (shoulder, brisket, rib and fore shank). Furthermore, the hind part percentage was divided into three primal cuts (flank, hind leg and loin) as described by Romans and Ziegler (1974) [20] and offal weights were recorded after slaughtering.

Net weight at slaughter (NWS) was calculated as body weight at slaughter (LWS) minus offal.

Moisture was determined in an oven at 105 ◦C until a constant weight was reached. Protein, fat and ash were measured with procedures described by Talbot, *et al.* (1964) [28]. The pH was determined by weight, cutting 10g of ground muscle, and

placing in Waring blender and added with 100 ml of distilled water. This was blanched for 10 seconds and the slurry was poured into a 250 ml beaker. The pH meter was adjusted with standard buffer, and then the electrodes were immersed into the slurry to measure pH. The water-holding capacity (WHC) was measured by the method described by Wierbicki and Demfeerage (1958) [29]. Bicep femoris muscle was used for measurement of meat properties and chemical characteristics.
The data collected were analyzed using one-way analyses of variance (ANOVA) using SAS (2001). Significant difference among treatment means was determined using the Least Square Difference (Gomez and Gomez, 1995) [10].

Results and Discussion

Dressing Percentage

Table 1 shows the effects of feeding male crossbred kids with different raw milk, milk replacer and 50% soybean milk +50% goat milk on carcass characteristics. Slaughter weight of crossbred kids was significantly different across treatments (*P*<0.05). Average hot and cool carcass weights and dressing percentage of crossbred kids were significantly different (*P*<0.05). The differences could be attributed to the slaughter weight of the crossbred kids. According to Assan (2015) [3]
Kids with heaviest slaughter weight had greater carcass weight and greater weight of internal organs than kids with smaller slaughter weight influencing the variation in dressing percentage.
Dressing percentage is an important factor to determine the potential yield of meat from an animal. Dressing percentage is measured by the carcass weight divided by the live weight times 100 (Gurung and Solaiman, 2010) [12].

Table 1: Average hot carcass weight, cool carcass, dressing percentage, carcass weight loss and wholesale cuts of male crossbred kids fed different raw milk, cow milk replacers and 50% soybean milk + 50% goat milk at pre-weaning stage

Parameters	Treatments				
	1	2	3	4	5
Whole Carcass					
Slaughter weight, kg	10.4±1.41a	9.00±1.41a	9.1±0.41a	5.8±0.28b	6.0±0.00b
Hot carcass, kg	4.50±0.64a	3.68±0.74a	4.1±0.20a	2.1±0.21b	2.2±0.18b
Cool carcass, kg	4.20±0.57a	3.50±0.82a	3.8±0.29a	1.9±0.18b	2.0±0.14b
Dressing percentage	40.39±0.06ab	38.6±3.03ab	42.3±3.9a	32.8±4.6b	33.3±2.4b
Carcass weight loss, kg	0.30±0.07	0.18±0.78	0.26±0.10	0.20±0.04	0.23±0.04
Carcass weight loss, %	6.62±0.64	5.10±3.11	6.35±2.67	9.65±0.81	10.0±0.79
Wholesale Cuts, g					
Shoulder	590.25 ±62.58a	409.75 ±73.89b	499.75 ±13.79ab	257.25 ±24.39c	284.50 ±36.06c
Brisket	206.50 ±23.33a	169.25 ±58.33a	211.75 ±33.58a	91.50 ±7.07b	95.75 ±1.06b
Rib	149.50 ±15.56a	126.75 ±40.66a	140.00 ±15.56a	61.00 ±4.24b	68.75 ±1.77b
Fore shank	200.50 ±56.57ab	228.50 ±55.15a	191.00 ±2.12abc	122.75 ±10.96bc	98.50 ±3.54b
Flank	82.00 ±2.12ab	78.75 ±36.42abc	85.50 ±6.36a	34.75 ±6.01b	38.50 ±1.41bc
Hind leg	711.25 ±124.80a	573 ±109.60a	636.25 ±60.46a	315.25 ±30.05b	341.25 ±32.88b
Loin	149.25 ±10.96a	130.00 ±29.70a	155.00 ±14.14a	63.25 ±12.37b	68.00 ±3.54b

[1]For each variable, means followed by a common superscript are not significantly different at 5% level
Legend: T1-Goat Milk, T2 - Cow Milk, T3 - Buffalo Milk, T4 – Milk Replacer and T5 – 50% Soybean Milk + 50% Goat Milk

Hot and cool carcass weights of male crossbred kids fed with goat milk (T1), cow milk (T2) and buffalo milk (T3) were significantly different compared to male crossbred kids fed cow milk replacer (T4) and 50% soybean milk + 50% goat milk (T5). The carcass percentage of male crossbred kids under different treatments recorded similar pattern. The results of the present study were in accordance with those reported by Gurung and Solaiman (2010) [12], that dressing percentage of goats usually is not more than 50%.
Meanwhile, the mean carcass shrinkage and carcass shrinkage percentage were not significantly different (*P*>0.05) across treatments. The differences in dressing percentage at pre-weaning stage could be attributed to higher slaughter weight at T1, T2 and T3. Swatland (1984) [27] reported that in carcass assessment, carcass weight, carcass percentage, thick back fat, and carcass pieces sold are important considerations.

Wholesale Cuts

Meat fabrication refers to the breaking down of the whole carcass of an animal into wholesale and retail cuts in the form of bone and meat. The results of the study showed that there were significant differences (*P*<0.05) on the yield of wholesale cuts at pre-weaning stage (Table 1).
For the fore quarter, the shoulder recorded the heaviest (590 g) wholesale cut for male crossbred kids fed goat milk, followed by kids fed with buffalo milk (499g) and those fed cow milk (409g) compared with those fed commercial cow milk replacer and soybean milk at 257.25g and 284.50g, respectively. For the brisket, male crossbred kids under T1 (206.50g), T2 (169.25g) and T3 (211.7g) were significantly different from those under T4 (91.50g) and T5 (95.75g). Moreover, rib weights in male crossbred kids under T1 (149.50g), T2 (126.75g) and T3 (140.00g) were significantly different from those under T4 (61.00g) and T5 (68.75g). Fore shank weight of male crossbred kids was significantly different (P<0.05). Kids under T2 (228.50g) were heavier then male crossbred kids under T1 (200.50g) and kids under T3 and T4 (191.00g and 122.75g). While, the lowest are the male crossbred kids under T5 (98.50g).
For the hind quarter, significant differences (P<0.05) were observed across treatments at pre-weaning stage. Flank weight was highest in male crossbred kids under T3 (85.50 g) followed by those in T1 (82.00 g) and T2 (78.75 g) then T5 (38.50 g) and the lowest is for male crossbred kids under T4 (34.75 g). Hind leg and loin weights of kids under T1 (711.25g), T2 (573.00g) and T3 636.25g) were significantly heavier then those in T4 (315.25g) and T5 (341.25g).
Data suggest that at pre-weaning stage, fore and hind quarter yield of male crossbred kids were affected by different raw milk, commercial cow milk replacer and 50% soybean milk +

50% goat milk. These differences could be attributed to the higher slaughter and cool carcass weights of male crossbred kids fed goat milk, cow milk and buffalo milk compared to cow milk replacer and 50% soybean milk + 50% goat milk. Sebsibe (2008) [22] pointed out that a major cause contributing to such low meat yield is the common practice of slaughtering animals at immature body weights, 18–20 kg for sheep and 16–18 kg for goats. Moreover, he stated that one of the major factors affecting carcass composition was carcass weight.

Carcass Chemical Characteristics

The results of the study on the effects of different raw milk, milk replacer and 50% soybean milk + 50% goat milk on the chemical characteristics of carcass are shown in Table 2.

At pre-weaning stage, mean protein content did not show significant differences (P>0.05). However, there were significant differences (P<0.05) on the percentage of water, fat and ash contents. Water content of crossbred kids under T4 (78.1%) was higher compared to those under T1, T2, T3 and T5 (76.3%, 75.7%, 74.0% and 76.8% respectively). However, the differences of water content which ranged from 74% to 78% were still in the normal ranges of meat water content. According to Aberle *et al*. (2001) [1] the water content of meat is 65 – 80% with on average 75%.

Table 2: Carcass chemical characteristics of male crossbred kids fed different raw milk, cow milk replacers and 50% soybean milk + 50% goat milk

Chemical Parameters	Treatments				
	1	2	3	4	5
Water content	76.3±0.45b	75.7±0.44b	74.0±0.56c	78.0±0.72a	76.8±0.84ab
Crude protein	20.3±0.27	20.5±0.64	22±1.55	19.3±0.99	19.2±0.99
Crude fat	1.88±0.41b	2.05±0.51ab	3.61±0.99a	1.41±0.24b	2.89±0.71ab
Ash	1.34±0.01b	1.35±0.00b	1.40±0.02a	1.25±0.02c	1.10±0.01d

[1]For each variable, means followed by a common superscript are not significantly different at 5% level

Legend: T1- Goat Milk, T2 - Cow Milk, T3 - Buffalo Milk, T4 – Milk Replacer and T5 – 50% Soybean Milk + 50% Goat Milk

Fat content of male crossbred kids under T3 (3.61%) was higher compared to those under T2 (2.05%) and T5 (2.89%). Subsequently, kids under T1 (1.88%) and T4 (1.41%) recorded the lowest across treatments. The highest fat content under treatment T3 may be due to high fat content of buffalo milk. Barłowska *et al*. (2011) [5] reported that buffalo raw milk has higher fat content (4.90%) compared to other raw milk from different animals. Hajorostamloo (2009) [13] reported that fat content of buffalo raw milk is 7.5% with an energy value of 99 Kcal ranging from 71 to 118 Kcal. Soeparno (2005) [25] stated that nutrition can affect and change the level of fatty carcass in certain body weights and carcasses from livestock fed high-energy feed contain more fat than those fed low-energy feed. The internal fat is highly variable and can be influenced by genotype (Soeparno, 2005) [25], nutrition (Bezerra *et al*., 2010) [6] age, slaughter weight (Al-Owaimer *et al*., 2013) [2], physiological condition, and physical activities (Solaiman *et al*., 2011) [24]. Lowest fat is noted in kids fed commercial cow milk replacer and raw goat milk. The lowest fat content can be associated with low fat and energy of commercial cow milk replacer. Bañón *et al*. (2006) [4] reported that kids fed goat milk and milk replacers were low fat and cholesterol.

The percentage of meat ash content was significantly different in kids under T3 (1.40%) than those from crossbred kids under T1 (1.34%) and T2 (1.35%). Lowest percentage of meat ash content was observed in male crossbred kids under T4 and T5 with 1.25% and 1.10%, respectively. The difference of ash content was associated with protein content where in T1, T2 and T3 had higher content of protein and fat. Ash content is related to protein and fat content of meat (Merkel, 1971) [17]

Conclusions

Results of the study reveal that there were differences in carcass percentage at pre- weaning stage could be due to treatments and attributed to slaughter weight. Significant differences were observed on hot and cool carcass and further the shoulder and fore shank of carcasses of kids. This could be accounted to the higher body weight of kids with fully developed rumen and intestinal tract and contents. Furthermore, the results of the study showed differences on chemical quality of meat. Those differences were on water content, crude fat and ash. Milk replacer can be profitably used in kid rearing without any negative effects on growth. This could be attributed to the comparably lower market price of milk replacer than goat milk. Thus, results of the study demonstrated the importance of goat raising with the use of milk replacer in rural communities. Through this practice, small goat raisers are given better opportunities of increasing their profit from selling goat's milk which commands high market price.

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