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Effects of soybean milk replacer on growth, meat quality, rumen and gonad development of goats

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ABSTRACT

The present study was aimed to determine the effect of soymilk as milk replacer on growth, carcass characteristics, rumen development, ovarian morphology and testicular development in kids. Twenty four Black Bengal kids were randomly allocated to three groups each containing 5 females and 3 males. One group was reared on 100 % whole milk, the second on 75% whole milk + 25% soymilk, and the third on 50% whole milk + 50% soymilk. Blood samples were collected to determine red and white blood cell counts, haemoglobin and packed cell volume. At 4 months of age the kids were sacrificed to examine carcass characteristics and to collect ovaries, testes and rumen samples for histological examination. Growth of kids in terms of live weight gain and pre-slaughter body measurements did not show any significant change due to feeding milk replacers. Kids fed whole milk were lighter at slaughter (4.93 ± 1.13 kg; mean ± SD) than those fed 25% (5.40 ± 0.62 kg) or 50% (5.34 ± 0.93 kg; NS) soymilk. Carcass weight, dressing percentage and chemical composition (DM, OM, EE and ash) of meat did not differ significantly. Histological examination revealed that the percentage of different types of ovarian follicles did not differ significantly among the treatment groups. The number of seminiferous tubules was significantly higher in milk replacer fed kids (25% soymilk 81.7 ± 3.78; 50% soymilk 86.7 ± 3.51) than whole milk fed control (71.7 ± 3.05) although the diameters did not differ significantly. In conclusion, whole milk could be replaced by soymilk up to 50% without significant effects on growth, carcass characteristics and rumen and gonad development.

1. Introduction

Black Bengal goats are dwarf meat type goats usually distributed in Bangladesh and its surrounding areas in India. They are popular for their adaptability in hot and humid environment, high prolificacy, delicious meat and skin softness. Low milk yield and short lactation length are often recorded as major challenges for rearing their kids. Insufficient milk produced by the doe is a major limiting factor responsible for higher kid mortality. Thus artificial feeding (bottle feeding) of new born is essential to overcome the scarcity of milk produced by dams. Due to the high cost of and demand for cow milk, artificial rearing of kids with milk replacers has been considered an economic and alternate way to save the kids. It is difficult to find an acceptable alternate to milk protein, the major costly ingredient of milk replacer.

Soybean is a source of high quality, relatively inexpensive protein that has potential for use in a milk replacer (Colvin and Ramsey, 1968; Ghorbani et al., 2007). Soy protein sources such as soy protein concentrate and soy protein isolate have partly been used in milk replacers (Silva et al., 1986; Drackley et al., 2006). Effects of soyflour in milk replacer on the performance of artificially reared lambs were studied by Heany and Shrestha (1987). They reported that there were no significant differences in daily gains from birth to weaning and post-weaning feed conversions among lambs fed standard milk replacer with all the protein provided by milk products and those fed milk replacer containing soy protein.

Soybeans contain anti-nutritional factors, which limit their use as a protein source for milk replacers. Trypsin inhibitor (TI), present in most soy flours and concentrates, inhibits the activity of bovine trypsin (Flavin, 1982). A reduction in proteolytic activity probably contributes to the poor digestibility of soy proteins in the young calf. Digestibilities have been reported as low as 50 and 75% for soy flour and soy protein concentrate, respectively, compared with 93% for milk protein (Nitzan et al., 1972). Growth, protein and dry matter digestibility, nitrogen retention, and morphology of the

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Table 1
Chemical composition of whole milk and soymilk replacers fed to kids.

Constituents (g/kg; fresh basis)	Whole milk	Soymilk	25% Whole milk and 75% soymilk	50% Whole milk and 50% soymilk
Total solids	132.5	107	126.1	119.7
Fat	49	27	43.5	37.5
Protein	30	40	32.5	35
Lactose/carbohydrates	46	34	43	40
Ash	7.5	6	7.1	6.7

intestinal mucosa of calves on the all milk-protein diet were superior to those of calves on diets containing a soy product (Dawson et al., 1988). Soy protein contains antigenic and phenolic compounds which adversely affect intestinal integrity and calf growth (Gardner et al., 1990; Drackley et al., 2006). Feeding soy protein supplemented with amino acid diet caused a reduced mucosal protein concentration and a reduced protein: RNA ratio in the jejunum compared with the control diet (Kuhla et al., 2007). In feeding milk replacer with 20% of total protein from soy protein and supplemented with dietary amines, Grant et al. (1989) reported a reduced mucosal protein concentration, reduced epithelial cell proliferation, and diminished efficiency of epithelial protein synthesis in the small intestinal mucosa in calves.

When a goat kid is born, its rumen is about 30 per cent of the total stomach volume, while the abomasum is about 70 per cent. Hence, digestion in the goat kid is like that of a monogastric animal. When the suckling goat kid starts to eat fibrous material during the first or second week after birth, the rumen, reticulum, and omasum gradually develop in size and function. After approximately two months, the four stomach compartments reach their relative adult proportions. Rumen papillae length and width, rumen wall thickness, and papillae density is influenced by dietary factors (Brownlee, 1956; Harrison et al., 1960; Tamate et al., 1962). Rumen development of milk replacer fed kids has been studied by Hamada et al. (1976). They reported that the development of rumen, liver and heart is related to the growth rate and solid food intake of kids. However, the effects of milk replacer feeding on development of rumen and other organs have not been understood well.

Milk is a unique food for infants that supplies a lot of nutrients essential for the growth and organ development of young mammals. However, milk is an expensive commodity which should be prioritized for the human food chain. Terui et al. (1996) demonstrated that wheat gluten can replace milk protein up to 50% in milk replacer without compromising the growth of calves. Ghorbani et al. (2007) suggested that replacing 25% rather than 50% of whole milk with soymilk may be the optimum use of soymilk as a milk replacer during the first 2–3 week of age in calves. Replacing 60% of the whey proteins in an all-milk protein milk replacer with soy protein concentrate decreased growth rates and feed efficiency and decreased villus height and crypt depth in the jejunum and villus height in the ileum (Drackley et al., 2006) of calves. The proportion of milk to be replaced by soymilk is not understood well. In the present study, 25% and 50% milk were replaced by soymilk, and the effects of these milk replacers on growth, carcass characteristics, blood components and development of rumen and gonads have been examined in Black Bengal kids.

2. Materials and methods

2.1. Animal and management

Twenty four Black Bengal kids of 3–4 weeks old were divided into three groups (Groups A–C) to equalize for initial weight, litter size of their dam, parity and dam's live weight. Each group consisted of eight kids (5 females and 3 males in each group). They were housed in 3 separate pens. In each pen, 8 kids were kept. The floor space per kid was 13.33 sq. ft. The house was well ventilated. Every day the floor, feeder and water trough were cleaned using phenyl as antiseptic. Separate feeder was used for roughage and concentrate feeding. The three groups of kids were fed individually on different milk treatments as follows: A — 100% whole milk, B — 75% whole milk + 25% soymilk, C — 50% whole milk + 50% soymilk.

Kids were fed three times daily up to 8 weeks old and received a total quantity of milk replacer equal to 10% of their live weight per day. From 9 to 11 weeks old, kids were fed twice daily receiving a daily total equal to 1/15th live weight. Thereafter, the amount of milk replacer was reduced to 1/25th live weight fed once daily up to 14 weeks old. Gradually the amount of milk replacer was further reduced to zero by the end of week 17. Concentrate mixture (24% crude protein) and green grasses were supplied ad libitum. Room temperature ranged from 22 to 25 °C between day and night. This study was found ethically sound by Bangladesh Agricultural University Research System (BAURES).

2.2. Preparation of soymilk and milk replacer

Soymilk was prepared from yellow soybeans, which were ground to produce soy flour. An amount of 125 g powder was dissolved in 1 L of water by stirring. Thereafter, soymilk was boiled at 100 °C for 10–15 min with constant stirring. After proper cooling, soymilk was supplied to the kids. Then soymilk was mixed with whole milk according to the stated experimental design. Milk samples were analyzed to determine the dry matter, fat, protein, lactose, ash and solids-not-fat (SNF) content by using the procedure described by Aggarwala and Sharma (1961) and AOAC (1984). Comparative chemical composition of milk and milk replacers are shown in Table 1.

2.3. Live weight

Each kid was weighed weekly at 8:00 am using a digital balance (T-Scale, Taiwan). The kids were kept off fed overnight before weighing.

2.4. Collection and processing of blood

Blood samples were collected after 7 weeks of experimental period at 9.00 am by jugular vein puncture into evacuated tubes containing EDTA for determination of blood components (red blood cell, white blood cell, haemoglobin and packed cell volume).

2.5. Carcass and non-carcass variates

Live weight, length of body, heart girth, circumference and length of neck, and height at withers of each kid were recorded prior to sacrifice. Kids were fasted overnight and sacrificed using the approved "Halal" method. By this method, goats were bled by cutting throat and then slaughtered by severing the head at its articulation on the occipito-atlantal space. At the time of sacrifice,