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Research Article

Effect of Dietary Supplementation with Propylene Glycol on Blood Metabolites and Hormones of Nili-Ravi Buffalo Heifers

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Abstract: The current study was designed to investigate the effects of propylene glycol (PG) on blood metabolites, feed intake and fertility in buffalo heifers. For this purpose, 12 Nili-Ravi buffalo heifers were selected and divided into three groups A, B and C. Group A was kept as control while group B was supplemented with 150 g of PG and group C was supplemented with 300 g propylene glycol per animal per day for 30 days. Blood samples were taken on day 0, then 1st, 3rd, 5th and 7th week after initiation of PG supplementation. The serum glucose, triglycerides, total protein, albumin, alanine transaminase, total cholesterol, blood urea nitrogen, oestrogen and progesterone were determined. Results revealed that serum glucose level significantly ($P<0.05$) increased in both treated group as compared to control group. Total protein, alanine aminotransferase (ALT), albumin and progesterone concentrations increased significantly ($P<0.05$) in treated groups as compared to control group. In treated groups serum cholesterol, blood urea nitrogen, and triglycerides are significantly decreased ($P<0.05$). Based on results of the present and previous studies, it was concluded that feed supplementation of propylene glycol on blood metabolites and reproductive hormones showed remarkable changes.

Keywords: Supplementation, Propylene Glycol, Blood metabolites, Nili-Ravi Buffalo

1. INTRODUCTION

Buffalo is found in more than 50 countries of the world. It has capacity to adopt itself in changing environment, atmosphere, geography and tropical conditions. In Pakistan, Buffalo mainly raised for milk production, sharing 65% of total milk production and their male calves contribute in meat industry as well [1]. Buffalo milk is preferred in whole country and sells at a high rate as compared to cow's milk because of higher milk fat and solid constituents. The average milk yield per lactation of Nili-Ravi buffalo is 2430 liters but it has capacity to yield above 5000 liters per lactation [2]. Buffalo is an important element of livestock sector of Pakistan as it provides livelihood to a considerable portion of people living in villages. Among major economic problem responsible for poor reproductive performance of buffalo, late puberty, long calving intervals, and poor estrus expression - especially during summer months and seasonality are important

Body metabolic and nutritional status of animals are associated with reproductive efficiency, nevertheless, its mechanism is unknown [3]. Concentration of blood metabolites, such as leptin, growth hormone, insulin-like growth factor (IGF-1) and insulin regulate the central nervous system to control the secretion of gonadotrophin. Blood insulin level and ovarian activity of dairy cows in postpartum period can be regulated by varying dietary starch and fat supply [4]. Plasma level of insulin and glucose are increased after dietary propylene glycol supplementation [5]. After oral supplementation a minor amount of propylene glycol is metabolized to propionate. Most of propylene glycol (PG) by pass the rumen

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unchanged to be converted to glucose in the liver. PG is converted to glucose in liver via lactaldehyde pathway and later oxidation to lactate take place. Propionate in liver is converted to pyruvate and in glucose via oxaloacetate. Propylene glycol increases the plasma concentration of glucose and insulin but its underlying mechanism is not understood [6]. Propylene glycol administration elevates IGF-1. IGF-1 plays very important role in steroid hormone synthesis, maturation of follicle, ovulation, fertilization, attaching of concept us to uterine wall and in development of embryo [7]. An elevated concentration of insulin during the oestrous cycle can increase the number of follicles [8]. Animals supplemented with propylene glycol exhibited their first ovulation after parturition as compared to control group. Propylene glycol supplemented in feed or administered orally improves fertility and metabolic status of dairy animals [9]. Keeping in view the limited information about the propylene glycol on health of buffalo under the climatic conditions of Pakistan, this study was planned.

2. MATERIALS AND METHODS

2.1 Experimental Animals

The study was carried out to determine the effects of dietary supplementation of propylene glycol on blood metabolites and reproductive organs of buffalo heifers having age from 24-30 months. For this purpose, 12 healthy buffalo heifers were randomly allocated into 3 groups, the experiment was carried out at Proka Farm University of Agriculture Faisalabad. Group A was kept as non-treated while B and C group were supplemented with 150g and 300g of propylene glycol, respectively, mixed in routine ration, which consisted on wheat straw, berseem and concentrate mixture for a period of 30 days. Propylene glycol is a colorless fluid and sprayed over ration.

2.2 Blood collection

Animals were restrained in cattle crush at farm for the collection of blood samples. Blood samples (10ml) were collected from jugular vein, under hygienic precautions, into gel and clot activator and serum was stored at 4 °C for further use [10]. Blood collection was done on day 0, after 1st, 3rd, 5th and 7th week of PG supplementation.

2.3 Biochemical and hormonal Analysis

Analysis was carried out to determine various biochemical compounds i.e., glucose, cholesterol, total proteins, albumin, ALT, triglycerides and blood urea nitrogen in the serum using commercially available standard kits and hormonal profile (estrogen and progesterone) by using Enzyme Linked Immunosorbent Assay (ELISA) Germany.

2.4 Statistical Analysis

Mean values (± SEM) of concentration of different parameters observed were calculated. Data were analysed by analysis of variance using general linear model procedure [11]. Duncan's Multiple Range Test [12] was applied for multiple mean comparison where ever significance variation indicated by ANOVA.

3. RESULTS

The results of the study showed that serum glucose levels were higher ($P<0.05$) in treatment groups B (51.49 ± 9.60) and C (52.54 ± 9.57) as compared to control group (39.42 ± 0.76).The group B (8.022 ± 0.17 g/dl) and C (8.310 ± 0.17 g/dl) had significantly higher total serum protein concentration than group A (6.920 ± 0.05 g/dl). The group B & C were (3.140 ± 0.09, 3.259 ± 0.07), significantly increased ($P<0.05$) as compared to A (3.14 ± 0.09). serum triglycerides were significantly decreased ($P<0.05$) both in groups B & C (43.567 ± 4.53&41.281 ± 6.47) treated with PG as contrast to mean value of control group A (48.637 ± 0.40). Serum cholesterol levels were significantly lower in both groups as compared to control group A (51.851 ± 1.14), while between group B & C (40.164 ± 6.48 & 39.591 ± 6.74) these were non-significant with each other. Blood urea nitrogen were decreased both in treated group as compared to control group. Level of serum ALT concentration was increased in groups treated with 150 gm & 300 gm of PG as compared to control group. Serum progesterone level significantly increased ($P<0.05$) in groups B & C (5.301 ± 3.78 & 5.415 ± 3.55) as contrast to control group A (1.478 ± 0.17). Serum estrogen level increased with PG treated groups (6.229 ± 2.73 & 6.5552 ± 2.80) as compared to control group A (3.457 ± 1.41).

Table 1: Serum biochemical metabolites and hormonal profile in control and treated groups of buffalo heifers treated with propylene glycol.

Serum parameters	Group A	Group B (150g PG)	Group C (300 g PG)
Serum glucose (mg/dl)	39.44 ± 0.76^{C}	51.49 ± 9.60^{B}	52.54 ± 9.57^{A}
Serum total protein (g/dl)	6.90 ± 0.09^{B}	8.07 ± 0.69^{A}	8.20 ± 0.74^{A}
Serum albumin (g/dl)	3.14 ± 0.09^{B}	3.25 ± 0.07^{AB}	3.45 ± 0.10^{A}
Serum triglycerides (mg/dl)	48.63 ± 0.40^{A}	43.56 ± 4.53^{B}	41.28 ± 6.47^{C}
Serum cholesterol (mg/dl)	51.85 ± 1.14^{A}	40.16 ± 6.48^{B}	39.59 ± 6.74^{B}
Blood urea nitrogen (mg/dl)	42.22 ± 1.45^{A}	36.77 ± 4.39^{B}	35.59 ± 5.53^{C}
Serum ALT (U/L)	30.74 ± 0.63^{C}	36.62 ± 4.54^{B}	37.76 ± 6.95^{A}
Serum progesterone (ng/ml)	1.47 ± 0.17^{B}	5.30 ± 3.78^{A}	5.41 ± 3.55^{A}
Serum estrogen (pg/ml)	3.45 ± 1.41^{B}	6.22 ± 2.73^{A}	6.55 ± 2.80^{A}

4. DISCUSSION

In this study, the authors attempted to clarify the potential effects of propylene glycol on serum biochemical metabolites in heifer buffalo. Serum glucose concentration was significantly ($P<0.05$) raised by supplementation of 150 and 300 gm of propylene glycol per animal per day in buffalo heifers. Our results of glucose concentration are in line with Gamarra et al. [13], who reported that concentrations of glucose were raised at 4 h after PG supplementation for the groups administered with propylene glycol 150 and propylene glycol 300 g as compared with day 0. Kristensen et al. [14] suggested that propanol may setup an insulin resistance thus hinder the uptake of glucose by insulin-sensitive tissues and thereby cause glucose concentration to increase. The results of present study showed significant increase ($P < 0.05$) in total serum protein concentration in treatment groups, which in agreement with Ayoub et al. ([15] those who reported that total protein is significantly increased in cows supplied 200 ml propylene glycol 30 days postpartum [16]. Increase in total protein concentration is the result of dietary feeding or ruminal utilization of protein constituents in the feed [17]. Serum albumin and ALT concentration in groups treated with PG were significantly increased ($P < 0.05$). Serum albumin is early nutritional marker of protein level [18]. Ayoub et al. [15] reported that propylene glycol administration had no effect on albumin concentration while supplied 100ml and 200 ml propylene glycol to healthy pregnant cows from 30 days before calving to 30 days of lactation. The primary (principal) indicators of liver lesion and disorder in the liver function are revealed by its enzymes aspartate aminotransferase (AST), bilirubin, ALT and blood metabolites [19]. They also reported that propylene glycol has ability to reduce the liver enzymes concentration after its supplementation.

Significantly reduced level of triglycerides in treated groups ($P < 0.05$) are in line with the results of Ayoub et al. [15]. They also found that triglycerides concentration was significantly reduced in animals supplied with 200 ml of propylene glycol at 30 days postpartum. Results of our study are in line with Chiofalo et al. [20]. Nazifi et al. [21] who also studied decrease in triglyceride concentration. In dairy animals the variation in triglycerides concentrations are principal variable for fatty liver, because triglycerides generation and storage is the major metabolic fate of fatty acids when the oxidation capacity of liver is increased [22].Serum cholesterol concentration decreased significantly in buffalo heifers in group B and C supplied with 150 g and 300 g propylene glycol per day per animal respectively, which in agreement with the results of Ayoub et al. [15] they found that propylene glycol administration reduced cholesterol concentration after parturition. Grummer and Carroll [23] described the importance of cholesterol as a precursor of ovarian

steroidogenesis. Schlumbom et al. [24] suggested that propylene glycol administration has capacity to elevate the cholesterol concentration after the end of supplementation due to the reduced response of target tissues towards insulin that together with raised mobilization of fatty acids from adipose tissue, which make available new sources for fetal growth. Significant reduction ($P<0.05$) was observed in urea nitrogen level which revealed by results that propylene glycol has an encouraging effect on negative energy balance, [25]. Findings of our study support the results of Ayoub et al. [15], Rukkwamsuk [26], Lien et al. [10], Hidalgo et al. [27], Duncan [12] who found that propylene glycol supplementation decrease blood urea nitrogen in treated animals. Serum urea nitrogen is the sign of crude protein intake [28] as well as energy and protein balance in ruminant's diet. During the present study while measuring the blood reproductive hormones it was noticed that serum progesterone concentration raised significantly which are in line with Berlinguer et al. [29].

A supportive effect of a glycogenic supplement on progesterone concentrations was present in sheep. Gamarra et al. [13] also stated that short term propylene glycol supplementation mixed in feed affects concentration of metabolic hormones, progesterone concentration and the number of small follicles. Raised progesterone can be procured from metabolism in the liver and other organs and possibly there may be release of progesterone from the adrenal gland but the basic source of progesterone in blood from non-pregnant buffaloes is considered to be the Corpus Luteum [30]. Estrogen concentration increased in treated groups compared to control group but variation was insignificant but estrogen increased in animals that exhibited cyclicity during the trial that's why estrogen increased in treatment groups. Our results are comparable with results of Gamarra et al. [13] Those found that there was no effect of propylene glycol administration on oestradiol concentration.

5. CONCLUSION

It was concluded that feed supplementation of propylene glycol to buffalo heifers having age 24-30 months improved and estrogen. It may be proposed that propylene glycol may be used for welfare of health of buffaloes.

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