SUPPLEMENTING NON-CONVENTIONAL ENERGY SOURCES TO RATIONS FOR IMPROVING PRODUCTION AND REPRODUCTION PERFORMANCES OF DAIRY ZARAIBI NANNY GOATS

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ABSTRACT

The objective of the present study was to investigate the influence of non-conventional energy supplements to the basal diet on production and reproduction performances of dairy Zaraibi nanny goats. Ninety- two Zaraibi goats (35.92±2.41 kg body weight and aged < 30 months) were divided into four similar groups (n=23/group). The groups were assigned at random to receive four experimental rations. The control basal ration (T1) consisted of 60% concentrate feed mixture (CFM) plus 40 % rice straw (RS), T2 contained 50% CFM + 45% RS + 5% protect fat (PF) of Megalac®, T3 included 50% CFM + 45% RS + 5% corn steep liquor (CSL) and T4 comprised of 50% CFM + 45% RS + 2.5% CSL + 2.5% PF. All diets were offered to all goats 28 days before the breeding season, as flushing period, as well as through pregnancy and lactation. Dietary effects on LBW during pregnancy, reproduction performances, milk yield and composition during suckling and lactation and blood parameters post-suckling and lactation were studied. The results revealed that nanny goats fed T2 and T4 rations showed higher (P<0.05) LBW through different pregnancy stages than T1 and T3 rations. The does fed T2 and T4 diets attained significantly (P<0.05) better reproductive performance than those fed T1 and T3 ration. Fertility rate was significantly (P<0.05) better with T4 and T2 diets than T3 and T1 diets, being, 200.00%, 186.96%, 156.52% and 130.43%, respectively. The does fed T2, T3 and T4 diets had significantly more suckled milk by 40.85%, 22.68% and 52.11 % than control (T1). Meanwhile, the improved of energy supplement during lactation period ameliorated more milk harvest by 24.21%, 12.51% and 33.44% with T2, T3 and T4 rations than control. Milk composition had significant differences (P<0.05) among trial diets and lactation stages (suckling and lactation). The best milk composition was obtained with T2 and T4 compared to T1 and T3. The serum glucose concentration had slightly changed within T2, T3, T4 and T1 goats during suckling and milking periods. The serum triglycerides, cholesterol, LDL, HDL, AST and ALT were significantly (P<0.05) increased due to experimental rations and milking stage. From these results, it could be concluded that feeding dairy Zaraibi goats a diet containing cheap non-conventional energy specially a combination between CSL and PF could improve LBW during pregnancy, milk yield, milk composition and some blood parameters throughout suckling and lactation periods.

Keywords: *Dairy goats, reproduction, production, non-conventional energy, protected fat, corn steep liquor.*

INTRODUCTION

Nutrient requirements of animals in Egypt are not sufficient during some agriculture seasons. Nutrient requirements of goats including allowances for maintenance and production depend on their physiological state. In Egypt, feeding costs account for 50 to 75% of the total cost of ruminant livestock production (Safari *et al.,* 2011). Thence, it is pressing that feeding practices have to ensure the most efficient production of livestock products with maximum economic return. The energy intake can be increased by incorporation of additional either concentrate or fat into the diet. Ruminants have a large requirement of energy, but energy intake may be limited by dry matter intake. Continuous attempts have been made to improve the energy value of low quality roughage through physiological, biological and chemical process or by supplying some energy industrial by-products. Diets containing fats are rapidly fermented in the rumen yielding high concentrations of lactate and volatile fatty acids that lead to decrease ruminal pH (Paengkoum *et al*., 2010). The energy requirements of high producing animals necessitate receiving maximum dry matter intake or increasing the energy content of ruminant feedstuffs by adding fat to the diet (Chay-Canul *et al*., 2011). Corn steep liquor (CSL) is an industrial by-product of wet milling process of maize-starch. It has light to dark brown colour, ensiled odor and acidic pH. It has been reported to be a good source of protein, energy and minerals for the animals. Wadhwani *et al*. (2010) reported that CSL is useful to increase the value of lower quality forage by increasing the energy and protein content without increasing fibre intake. Also, the authors defined that CSL can be added during mixing to improve uniformity of dry feed and used as a dust suppressant. Feeding animals with protected fat (PF) offered the potential for increasing the absorption of unsaturated fatty acids from the small intestine. Hosam (2011) concluded that addition of calcium soap to the diets of lactating dairy goats in early lactation at the level of 3% has limited effect on milk production but improves the percentages of fat, protein, and total solids. Furthermore, the high energy (as PF) in dairy goat's diet pre-mating influence concentration of long-chain polyunsaturated fatty acids that might be beneficial for reproductive parameters (Hafez *et al*., 2011). Furthermore, energy supplement with fatty acids , such as butyric, oleic, polyunsaturated fatty acids especially Omega-3 fatty acids and conjugated linoleic acids, might have a potential anti-atherogenic or anti-carcinogenic role (Mostafa *et al*., 2012).

The purpose of this study was to supplement PF and/or CSL as non-conventional energy sources to ration as attempt to improve the production and reproduction of dairy Zaraibi goats.

MATERIALS AND METHODS

The study was carried out during breeding season at El-Serw Experimental Research Station belongs to Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture, Egypt.

Corn steep liquor and protected fat as sources of non-conventional energy

Corn steep liquor (CSL) is a major industrial by-product of corn starch processing. It is an inexpensive source of energy, minerals, vitamins, amino acids and other nutrients. Recently, CSL has been used as feed supplement for ruminants and reduce the amount of fungal inoculums. The typically chemical analysis of CSL is presented in Table 1.

Megalac® protected fat (PF) is palm fats produced by reacting palm fatty acid distillate with calcium hydroxide to form calcium soap. Calcium soaps are the cheapest and most widely used material to protect dairy fats and have been used in animal's nutrition for many years. The typically chemical analysis of PF is shown in Table 2.

Animals and experimental design:

Ninety-two dairy Zaraibi goats were used in this trial. Their initial live body weight (LBW) averaged 35.92±2.41kg and age was < 30 months. The goats were assigned into four similar groups (23 each) according to body weight and milk production. The four groups were assigned at random to the four experimental rations in a complete randomized block design. The nanny goats were fed the experimental rations for 28 days pre-breeding season (as flushing period) and up to end of the breeding season and during the last two months of pregnancy (trimester period). All groups received diets according to NRC (2007) recommended allowances for dairy goats.

Feeding management

The first group received a basal diet (T1) consisting of 60% concentrate feed mixture (CFM) plus 40% rice straw (RS) as a control diet. The second group T2 diet, included 50% CFM + 45% RS + 5% PF of Megalac®. The third group (T3) diet consisted of 50% CFM + 45% RS + 5% CSL. The fourth group (T4) diet contained 50% CFM + 45% RS + 2.5% PF + 2.5% CSL. The non-conventional energy sources were supplied to the basal ration according to dry matter consumed. The CFM was mixed immediately before feeding with energy materials and introduced at 8 am and 4 pm daily. Fresh water and minerals block were available all times of animals. Chemical analysis of CFM and RS were determined using standard procedures of AOAC (2007) and shown in Table 3.

Experimental procedures

Live body weight of does

Live body weights of does were recorded before morning feeding during pre-mating, post-mating, at trimester, one month pre-parturition, at 140 days pre-parturition, at 2 days post-partum then monthly during suckling (3 months) and lactation (3months) periods.

Reproduction performance

After mating season, the nanny goats which did not manifest heat through two oestrus cycles were considered pregnant. The conception rate, fertility, birth rate and litter size were estimated to highlight reproductive performance of does. Conception rate was calculated as number of does conceived / number of does mated. Fertility rate was measured as number of total kids born/ number of does mated. Single birth rate was recorded as number of does kidding single/ number of does kidded. Twins birth rate was calculated as number of does kidding twins/ number of does kidded. Triplet birth rate was calculated as the number of does kidding triplet/number of does kidded. Litter size was calculated as number of total kids born/number of does kidding. Also, LBW of kids were recorded biweekly throughout suckling period up to weaning.

Table 1: Chemical composition of CSL as non-conventional energy.

Chemical composition of CSL							
Energy sources	**DM**	**CP**	**Fat**	**Starch**	**NFE**	**Sugar**	**ME (MJ/kg/DM)**
CSL	43.00	33.50	1.00	17.40	Less 1.00	3.30	15.40

Source: Feed Guide Energy Products, Copyright © 2011 Castlegate James Australia Pty Ltd.

Table 2: Chemical composition of PF as non-conventional energy.

Items%	Ingredient concentrations
Oil	84.00
Calcium	9.00
Moisture	5.00
Fatty acids profile%	
C12 Lauric acids and C:14.0 Myristic acids	1.2
C16 Palmitic acids	48.0
C18.0 Stearic acids	5.0
C18.1 Oleic acids	36.0
C18.2 Linoleic acids	9.5
ME MJ/kg/DM	33.25

Source: Richard Webster Nutrition L. td: Protected Fat and Omega-3 Fish Oil Supplements.

Table 3: Chemical composition of CFM and RS.

Items	**Chemical composition %**							
	DM	**OM**	**CP**	**EE**	**CF**	**NFE**	**Ash**	***ME**
CFM	87.85	89.25	14.42	3.45	12.16	59.22	10.75	1.17
RS	92.83	80.23	3.08	1.49	36.88	38.78	19.77	0.81

* ME=Metabolizable energy (MJ/Kg//DM) calculated according to MAFF (1976).

Milk yield during suckling and lactation weeks

Amounts of suckling milk were estimated for T1, T2, T3 and T4 groups at 7, 15, 30, 45, 60, 75 and 90 days by oxytocin method. The method relied on injecting double doses (2 IU/doe) of oxytocin intravenously after kids were separated. After the first oxytocin dose injection by a minute the udder was emptied of residual milk, using hand milking and this amount of milk was discarded. The second oxytocin dose was injected after 4 hours elapse of kids' separation. Udder was then hand milked and milk yield was recorded. The amount of milk suckled during 24 hours was calculated by multiplying the actual milk yield obtained during the 4 hours (of kid's separation) by 6 as a factor.

The commercial milk yield was recorded after weaning through consecutive nine weeks of lactation to observe milk quantum at early lactation and persistency of milk yield. The mean of milk yield was assessed weekly for nine weeks as aggregation of daily hand milked yield at 5 am and 5 pm.

Milk composition during sucking and lactation weeks

During suckling months and lactation weeks an individual milk sample was taken for composition analysis according to Bradley *et al*. (1992). The Gross energy of milk (GEM Kcal/kg) was calculated according to Tyrell and Reid (1965).

Blood parameters at post- sucking and lactation weeks

Blood samples (10 ml/ doe) were collected individually in the morning before feeding from the jugular vein of five random goats of each group into clean tubes. Samples collected biweekly during suckling months and weekly during lactation weeks. After clotting, blood samples were centrifuged at 3000 rpm for 15 min. Then, blood serum was separated and stored at -20 °C until analysis. The concentrations of triglycerides, cholesterol, high density lipoprotein (HDL), glucose, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined using commercial kits (Diagnostic system Laboratories, Inc., USA). Then, serum low density lipoprotein (LDL) level was calculated according to Friedewald *et al*. (1972).

Statistical Analysis

Data obtained were subjected to statistical analysis using general linear model (GLM) procedure of SAS (2009) and significance was declared at P<0.05. Pregnancy rate values were statically tested using Chi square test.

RESULTS AND DISCUSSION

Live body weight of does

Figures 1 and 2 illustrate LBW of nanny goats during pregnancy stages and LBW of dams throughout suckling and lactation periods, respectively. The LBW at 140 days pre-parturition and at 2 days post-partum were significantly heavier than other events (P <0.05). The current results indicate that energy supplied in T2 and T4 diets had moderate effect on LBW of dams during partum stage. This result confirms with those of Yusuf *et al*. (2009) who found that diet supplementation with energy activated growth performance by improving the physical consistency of mash-type diet, enhancing micro ingredients, improving palatability and feed intake. The relative improvement of LBW with T4 diets might relate to combining effect of enhancing energy source and improvement of digestibility of the diets. Similarly, El-Shahat and Abo-El-Maaty (2010) elucidated that combination of basal diet with calcium salts and L-carnitine enhanced growth rate of ewes. Moreover, the relative best LBW in T4 diet might be a consequence for combining PF and CSL which provides energy and protein for tissue synthesis and metabolizm. This observation is consistent with Hassan *et al*. (2012) who suggested that feeding diets supplemented with different types of energy resulted in changes in the body weight of Zaraibi does. Energy supplement by CSL to diet surpassed T3 group in LBW compared to T1 group is mainly because CSL contains carbohydrates easily soluble for microbial fermentation in the rumen thus can improve fermentation. These findings are confirmed by Santos *et al*. (2012) who demonstrated that CSL releases rumen ammonia nitrogen with keto acids (carboxylic acid group and a ketone group) which synchronizes nitrogen and carbon in the rumen towards enhancing microbial proliferation that improves growth. However, during the physiological stress of milk production, particularly during the peak of lactation, goats tended to lose body weight. Similar trend was observed by Shittu *et al*. (2011) who established that animals lose weight during lactation, especially up to peak of lactation and during reproduction. Moreover, Otaru *et al.* (2011) affirmed that synthesis of goat milk largely depends on nutritional milk precursors present in blood plasma and taken up by the udder which is reflected on weight loss of goats.

Reproduction performance

Results presented in Table 4 identify that conception rate was significantly (P<0.05) lower for nanny goats received T1 diet (69.57%) than those fed T2 (100%), T3 (82.61%) and T4 (100%) diets. The fertility rate was significantly (P<0.05) higher with goats fed T4 (200.00%) and T2 (186.96%) than those fed T3 (156.52%) and T1 (130.43%). The treated groups (T2, T3 and T4) significantly (P<0.05) produced more triplet kids (23.80%, 22.22 % and 33.33 %, respectively) than does fed T1 (20.00%). Concerning the number of kids produced, does supplied with T4 gave (P<0.05) more kids (46 kids) than T3, T2 and T1 (36, 43, and 30 kids), respectively. Usually, supplementing energy to diets is one of the most important factors influence reproductive performance through increasing energy consumption and utilization efficiency. Similarly, Hafez *et al*. (2011) observed that high energy intake caused significantly higher pregnancy rate, number of kids born, fertility rate, kidding numbers, triplets rate and kid birth weight than low energy intake. In the present study, the highest reproductive performance was obtained with T4 diet which might be related to mixing the non-conventional energy types PF and CSL with basal diets. El-Shahat and Abo-El Maaty (2010) revealed that

Fig.1: LBW of nanny goats during pregnancy periods as affected by dietary treatments.

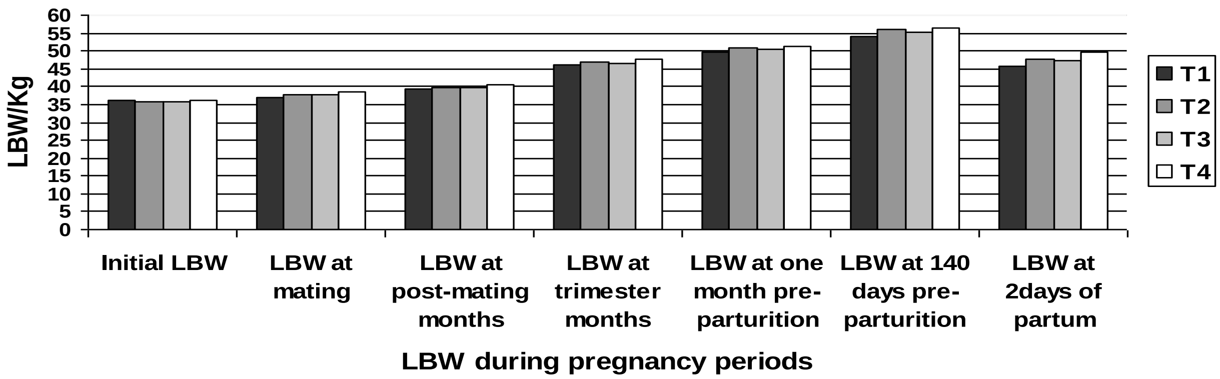


Fig.2: LBW of nanny goats during suckling and lactation periods as affected by dietary treatments.

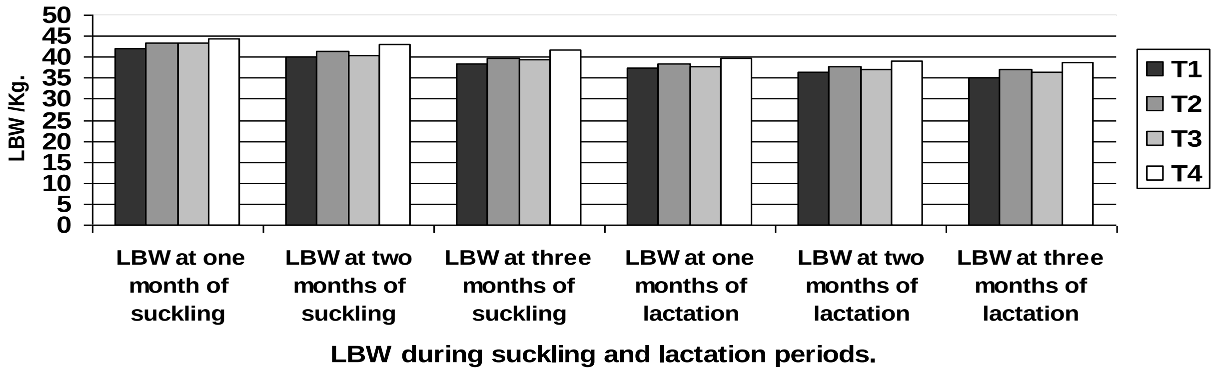
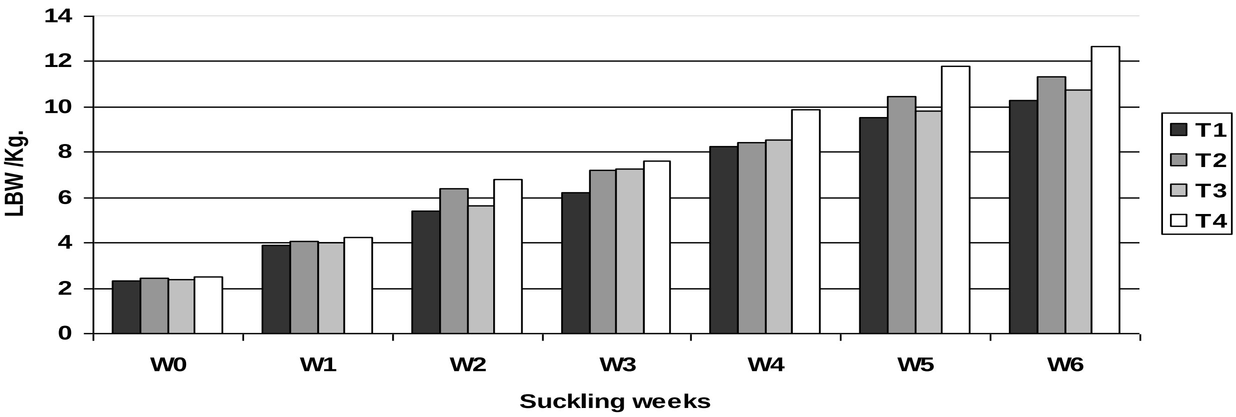


Table 4: Reproductive performance of dairy goats as affected by dietary treatments.

Items	Dietary treatments			
	T1	T2	T3	T4
Mated does	23	23	23	23
Conceived does	16	23	19	23
Conception rate, %	69.57^{c}	100^{a}	82.61^{b}	100.00^{a}
No. of does kidded	15	21	18	21
Total number of kids	30^{c}	43^{a}	36^{b}	46^{a}
Fertility does, %	130.43^{d}	186.96^{b}	156.52^{c}	200.00^{a}
No. of does kidding single	3	2	4	3
Single rate, %	20.00	9.53	22.22	14.29
No. of does kidding twins	9	14	10	11
Twinning rate, %	60.00	66.67	55.56	52.38
No. of does kidding triplet	3	5	4	7
Triplet rate, %	20.00^{c}	23.80^{b}	22.22^{b}	33.33 ^{a}
Litter size	2.00	2.05	2.00	2.19
No. of males	13	21	16	26
No. of females	17	22	20	20

Values with different superscripts in the same row, differ significantly (P<0.05).

Fig. 3: LBW of suckling kids as affected by dietary treatments.



supplementation of basal diet with L-carnitine alone did not improve reproductive performance, but combination of calcium salts with L-carnitine caused improvements in number and size of ovarian pre-ovulatory follicles and increased ovulation rate. In addition, T4 had reasonable amount of protein in CSL which enhance fermentation and made carbohydrates available for microbial activity in the rumen. Rosales-Nieto *et al*. (2011) found that protein quantity and quality have been shown to influence reproductive performance and played a major role in re-establishment of ovarian activity. Furthermore, Santos *et al*. (2008) suggested that feeding fat enhanced follicle growth, uterine prostaglandin (PG) secretion, embryo quality and maintenance of pregnancy. In the current work, goats nourished PF in T2 and T4 contained rich quantity of linoleic acid (9.5%) and oleic acid (36%) which probably caused higher procreation rate than diets of T1 and T3. This result is consistent with the study of Hutchinson *et al*. (2012) who suggested that dairy cattle received fat rich in linoleic acid had more plasma progesterone (P4), bigger corpora luteum and reinforcement uterine environment for embryo development. Generally, the improvement in ovulation, size of follicles and follicular growth are linked to the enhance of plasma LH secretion which is associated with energy supplementation to diets. The ovulation of larger follicles may results in formation of larger corpora lutea with increased steroidogenic capacity that results in greater progesterone production and higher conception rates (Ghattas and Nasra, 2010). On the other hand, El-Nour *et al*. (2012) concluded that the dietary protected fat is effective on maintaining reproductive performance which reflected on increased levels of lipid profiles, glucose, progesterone hormone and number of follicles. Furthermore, Dirandeh *et al*. (2013) concluded that feeding fat that contained linoleic acid and linolenic acid pre–parturition is considered a good treatment for parturition and delineation for improving fertility of lactating dairy cows.

LBW of kids during suckling period

As shown in Figure 3, there was no significant difference in kid's initial weight in week W0 up to W2 during suckling period for different types of diet. Starting from W3 up to W6, there was significant differences ($P<0.05$) between goats fed T4 and T2 diets than those fed T1 and T3 diets. The heaviest kid's weight was in does fed T4, T2 and T3 diets. This was related to flushing of lactating does by isoenergetic diets at trimester which transfers energy requirements to fetus compared to suckling kids from does nourished the control diet (T1). Karikari and Blasu (2009) concluded that under feeding during late pregnancy result in overall poor survival of dams, kidding rate, kid's birth weight and kid's growth. Moreover, flushing dams caused weight gain during pregnancy which often indicates pre-natal development of the fetus. Titi *et al*. (2008) recorded that LBW of dams (as evidence of healthy dams and flushing) had significant correlation with birth weight of the offspring. Furthermore, milk production of dose nourished high energy and beneficial substances were increased which develop growth performance of kids as reported by Safari *et al*. (2011). They referred the case of low growth performance of kids born to a reduced ability of dams to produce sufficient milk for the kids.

Milk yield during suckling and lactation periods

The suckling and milking yield of different goats fed the experimental rations is depicted in Figures 4 and 5, respectively. The suckling milk yield was significantly ($P<0.05$) higher for T4 and T2 does than T1 and T3 does. The total suckling milk yield were 1662, 2341, 2039 and 2528 gm for the does received T1, T2, T3 and T4 diets, respectively. Furthermore, does fed T2, T3 and T4 diets had improved suckling milk by 40.85%, 22.68% and 52.11 % over T1 diet, respectively. Regarding milking yield during lactation weeks (Fig. 5), the energy supplement to T2, T3 and T4 had a positive effect on the amounts of milk yielded compared to diet fed to T1. The milk produced by goats received T4 and T2 diets gave a higher quantity than goats fed T3 and T1 diets. As milking advanced, the quantities of milk produced by T2, T3 and T4 goats were significantly ($P<0.05$) better than T1 goats. The total lactation milk yields were 3110, 3836, 3499 and 4150 gm for goats receiving T1, T2, T3 and T4 rations, respectively. In this study, energy supplementation ameliorated milk harvest by 24.21%, 12.51% and 33.44% for T2, T3 and T4 rations, respectively. Moreover, goats nourished T2, T3 and T4 diets showed higher lactation curves and longer persistency than feeding T1. The peak lactation curve accounted 17.97 %, 8.35% and 25.82% in T2, T3 and T4 diets, respectively, more than T1. Whereas, persistency of milk yield continued three weeks (W2 up to W4) in T2, T3 and T4 goats, while extended one week only in T1 does (W3). The current study for persistency is in agreement with Pala and Koyuncu (2007) who reported that the average persistency period through milk production was attained at weeks 2 to 4 of lactation curve. Also, both authors defined that the worse persistency was probably because of losing secretory cells and that existing cells had less secretory activity. Milk yield was then gradually reduced with progress of lactation weeks in all goats. When ruminants' diet contained non-conventional energy (as PF), an increase in milk production occurred due to the great energy density presented (Sanz Sampelayo *et al*., 2002). Milk production is fundamentally determined by the animals' energy balance which is a greater important factor than aspects related to diet characteristics (Cieslak *et al.*, 2010). Thus, it can be deduced that feeding rich energy allows great efficiency of the metabolizable energy for milk production. Min *et al*. (2005) found positive correlation between amount of metabolizable energy (ME) and both milk yield or milk composition. In accordance with other studies on goat's milk yield, Otaru *et al*. (2011) revealed that feeds supplemented with different types of energy were effective on enhancing milk harvest. In addition, the use of energy seems to be an interesting technique during early lactation and it can improve the milk fatty acids characteristics towards a safer pattern (Mostafa *et al.*, 2012). Improvement in milk yield associated with supplemental calories that could refine energy balance. This trend is in harmony with Sultana *et al*. (2012) who stated that energy feeding might be diverted to infusion of propionic acid and acetic acid into body that shifts energy output to milk production. On the other hand, Titi and Fataftah (2013) revealed that energy supplements to the diet is an efficient mean to modify milk yield, fat content, and fatty acids composition in lactating ewes.

Fig. 4: Milk yield duriong sckulling period as affected by dietary treatments.

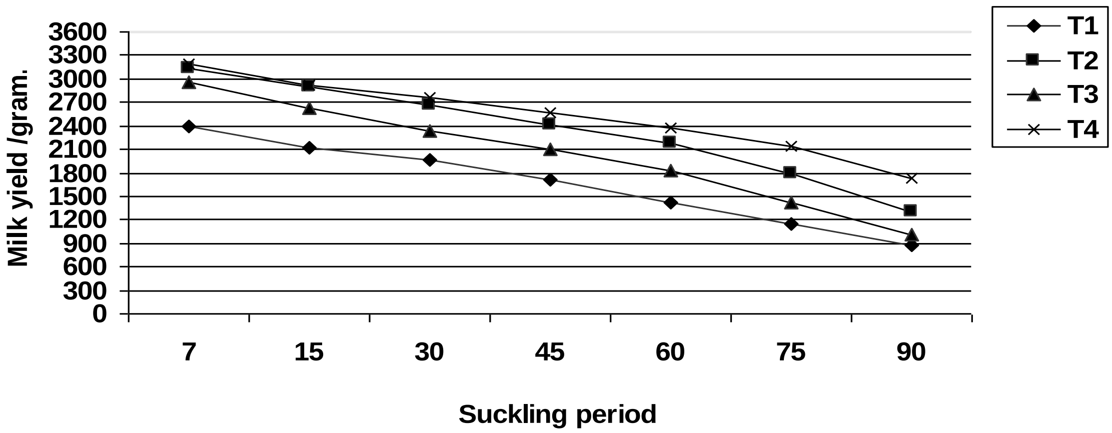
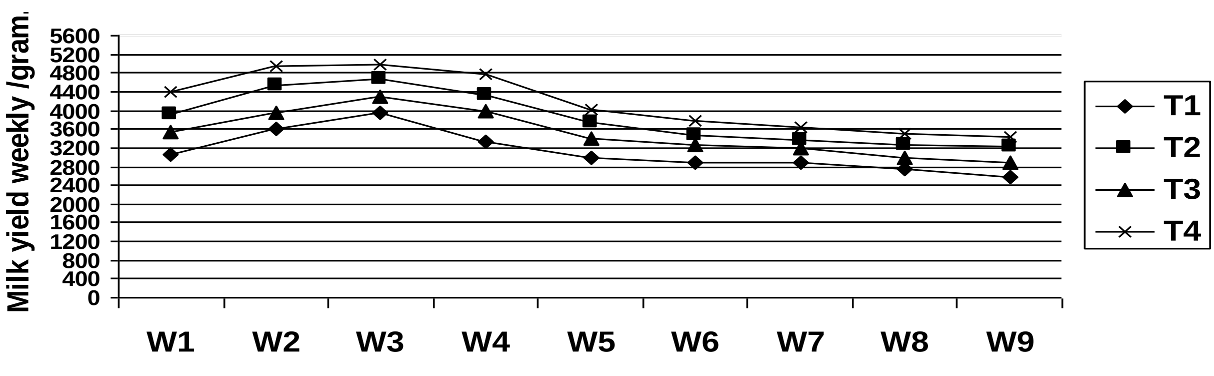


Fig. 5: Milk yield during lactation weeks as affected by dietary treatments



Milk composition during suckling and lactation periods

Chemical composition of milk during suckling and lactation periods in different treatments is presented in Table 5. It could be demonstrated that there were significant differences (P<0.05) in milk contents among the experimental groups during suckling and milking except milk protein percentage. The milk composition of fat, protein, lactose, total solids and gross energy appeared to be higher during suckling than milking stages. The milk composition of goats received T4 diet had greater fat, protein, lactase and gross milk energy than goats fed T1, T2 and T3 diets during both periods. Usually, energy supplemented to the basal diets of lactating goats attains increase energy density of the diet in order to increase milk production and composition (Zhang *et al*., 2006). Regarding fat content in milk, it was significantly (P<0.05) higher in does fed T2, T3 and T4 rations than does fed T1 ration. The milk fat is directly affected by energy intake (EL-Sanafawy, 2008). Furthermore, Martinez *et al*. (2010) indicated that supplementing the diet with PF increases ruminal fermentation and hence the ability of animal to increase the amount of milk fat. On the other hand, Bernal-Santos *et al*. (2003) stated that dairy cows supplemented with dietary fat source exhibited an increase in fat yield. However, Bernard *et al*. (2005) indicated different milk fat quantum as response to different energy sources in dairy cows.

Concerning, protein content in this study, no significant changes were observed among dietary treatments during both suckling and lactation periods. These results are supported by the results of Chilliard *et al*. (2003) who reported that goats milk protein content was not markedly changed in responses to dietary energy (as fat) supplementation. However, dietary supplementation with lipids usually has a negative effect on milk protein percent but protein may remain constant or increase by fat supplementation (Zhang *et al*., 2006). However, Junior *et al*. (2010) reported that utilization of dietary fat sources in diets could change milk protein content of lactating cows.

In connection with lactose content, it was significantly (P<0.05) lower in does fed T1 ration than those fed T2, T3 and T4 rations during suckling and milking periods. Similar results were reported by El-Shafie and El-Ashmay (2010) who observed that addition of energy (as sunflower seeds) to goat's ration showed significantly higher lactose content through suckling and lactation.

Lactose is the major osmotic regulator of milk whereas a strong positive correlation exists between lactose synthesis and milk yield (Roger *et al*., 2011). Moreover, Gantner and Kompan (2012) found that the number of secretory cells in the udder of goats decreased as lactation months advanced, but udder cells activity remained with reference to total solids content. Feeding T2, T3 and T4 rations showed significant (P<0.05) increase of total solids among the experimental groups and during both suckling and milking periods. The greatest total solid content noticed in T2 and T4 diets was due to the increase in fat percent of milk in these groups.

The general trend of change in total solids of dairy goat throughout suckling and lactation period is in full agreement with those obtained by El-Shafie and El-Ashmay (2010) and Hosam (2011). The highest gross energy of milk (GEM) (P<0.05) were in T4, T2 and T3, compared to T1 group during suckling and lactating periods. The milk energy output of lactating goats increased by addition of fat to the basal diets. The highest milk energy observed in T4 group was because of its higher components of energy especially milk fat. It was proposed that highest energy intake brought an increase in milk fat and energy production. Similarly, Titi *et al*. (2011) stated that goat supplemented with dietary energy sources (soybean and sunflower oil) gave variable effects on milk composition.

Blood serum parameters at post- suckling and lactation periods

The blood parameters post-suckling and lactation weeks are presented in Table 6. The biochemical blood profile showed clear significant differences (P<0.05) among experimental diets and periods of milk harvest except for glucose level. It is of interest to note that goats fed non-traditional energy attained changes in biochemical blood compared to control goats during suckling and lactation periods. Energy sources supplemented to T2, T3 and T4 diets could cause slight increase in serum glucose concentration than diet fed to T1. However, serum blood glucose booster in sucking than milking periods. Changes in glucose level may be due to the high dietary amount of long chain fatty acids that increase hepatic gluconeogenesis leading to increase propionate production in the rumen (Liel *et al.*, 2010). Energy supplements caused inconsiderable increase in the serum triglyceride compared to control diets in both suckling and lactating periods. Similar results were explained by Sampelayo *et al.* (2006) who defined that polyunsaturated fatty acids (PUFA) in high energy diet reduce lipolysis in the body, subsequently reduce plasma levels of nonesterified fatty acids (NEFA) and levels of triglycerides. In the current study, feed treatments did not have clear trend on levels of triglyceride during suckling and milking periods. Similar results were obtained by El-Shafie and El-Ashmay, (2010) who stated different values of triglyceride throughout suckling and milking periods in relation to outcome of feedstuffs intake, thus confounding their translation as nutritional biomarkers. The cholesterol, HDL and LDL indirectly reflect the degree of exogenous energy availability and the hepatic functionality. The high levels of serum cholesterol and LDL in T2 and T4 led to beneficial effect on hormonal synthesis and utilization. Hu *et al.* (2010) reported that luteal cells, luteinized granulose cells, fetal adrenal cells and placental cells preferentially utilize LDL leading to good reproductive parameters. Also, these authors reported that incubation cells with HDL causes an actual decrease in biosynthesis of steroid hormones. The results of the present study showed that diet supplied by non-conventional energy attained LDL percentages of 9.49%, 4.50% and 8.47% during suckling and 10.01%, 1.00% and 10.40% during milking weeks for T2, T3 and T4 diets, respectively. Also, the lowest HDL percentages were obtained in T4 during suckling (2.38%) and milking (5.86%) periods. The increase in serum total cholesterol level in trial goats may

Table 5: Milk composition during suckling and lactation period as affected by dietary treatments.

Items %	Dietary treatments			
	T1	T2	T3	T4
	Milk composition during suckling period			
Fat	4.63±0.36^{b}	5.46±0.28^{a}	5.19±0.26^{a}	5.67±0.34^{a}
Protein	2.49±0.11	2.61±0.09	2.64±0.13	2.69±0.10
Lactose	3.78±0.08^{b}	4.22±0.07^{a}	4.27±0.06^{a}	4.34±0.09^{a}
Ash	0.78±0.01	0.82±0.03	0.81±0.04	0.84±0.2
Total solids	11.68±0.14^{c}	13.11±0.16^{a}	12.91±0.12^{b}	13.54±0.15^{a}
Solids non fat	7.05±0.06	7.65±0.04	7.72±0.05	7.87±0.07
GEM (Kcal/kg)	717.23±11.22^{d}	823.28±13.17^{b}	801.82±15.10^{c}	853.47±18.11^{a}
	Milk composition during lactation period			
Fat	3.34±0.16^{b}	3.92±0.18^{a}	3.73±0.19^{a}	4.27±0.21^{a}
Protein	2.35±0.06	2.38±0.08	2.43±0.11	2.81±0.12
Lactose	3.42±0.08^{b}	3.72±0.10^{a}	3.84±0.09^{a}	3.91±0.06^{a}
Ash	0.71±0.01	0.75±0.03	0.73±0.02	0.76±0.04
Total solids	9.82±0.11^{c}	10.77±0.10^{b}	10.73±0.12^{b}	11.75±0.14^{a}
Solids non fat	6.48±0.08	6.85±0.05	7.00±0.06	7.48±0.07
***GEM (Kcal/kg)**	570.21±12.54^{d}	641.90±14.11^{b}	631.74±12.11^{c}	705.15±13.55^{a}

Values with different superscripts in the same row, differ significantly ($P<0.05$).
*GEM-=gross energy of milk.

Table 6: Blood serum parameters during suckling and lactation periods as affected by dietary treatments.

parameters	Dietary treatments			
	T1	T2	T3	T4
Blood parameters during suckling period				
Glucose, mg/dl	57.85±7.55	59.78±6.65	61.11±5.69	60.66±6.14
Triglycerides, mg/dl	88.18±8.13[b]	90.36±7.35[a]	86.49±9.25[b]	89.97±8.59[b]
Cholesterol, mg/dl	94.59±15.44[b]	103.13±12.26[a]	95.66±14.16[b]	100.62±15.13[a]
LDL, mg/dl	63.08±4.38[c]	69.07±5.22[a]	65.92±3.96[b]	68.42±6.82[a]
HDL, mg/dl	13.87±1.98[b]	15.98±3.35[a]	12.44±3.21[b]	14.20±2.84[b]
AST, IU/L	54.16±3.14[a]	47.55±4.11[b]	45.71±3.52[b]	46.46±3.33[b]
ALT, IU/L	24.88±2.26[a]	18.25±2.15[b]	16.52±1.95[b]	17.75±2.17[b]
Blood parameters during lactation period				
Glucose, mg/dl	56.44±4.25	57.33±5.11	59.69±6.72	58.35±4.95
Triglycerides, mg/dl	82.39±8.61[b]	89.67±7.46[a]	82.64±8.20[b]	84.44±7.59[b]
Cholesterol, mg/dl	90.22±13.65[b]	98.94±16.11[a]	89.16±15.29[b]	97.71±14.28[b]
LDL, mg/dl	60.77±3.95[b]	66.58±4.25[a]	61.37±5.01[b]	67.09±5.21[a]
HDL, mg/dl	12.97±5.33[b]	14.43±4.62[a]	11.26±4.69[b]	13.73±5.53[b]
AST, IU/L	53.99±4.23[a]	46.54±5.25[b]	44.15±4.65[b]	45.51±4.95[b]
ALT, IU/L	25.85±1.68[a]	19.65±1.33[b]	17.76±2.11[b]	18.49±1.11[b]

Values with different superscripts in the same row, differ significantly (P<0.05).

be due to action of energy supplementation which increases the lipoprotein cholesterol export by the intestine. Espinoza *et al*. (1997) concluded that energy balance in the diet promote the production of lipoproteins in the intestine which is the major site of de novo cholesterol synthesis (acetate) in ruminants. Also, these authors defined that lipoprotein would most probably be the reason behind the observed increase in serum cholesterol levels. Generally, Ghattas and Nasra (2010) stated that supplemental energy (as fat) increased plasma levels of cholesterol, triglycerides, high density HDL and LDL.

The activity of AST and ALT in blood serum goats was significantly different (P<0.05) among the experimental rations and during suckling and milking periods. The high AST level indicated damage in the muscles, heart, opposed to the liver, prolonged fasting, infectious, liver disease and extensive hepatic necrosis. The ALT is an enzyme which transfers amino group from alanine to ketoglutaric acid, forming glutamate pyruvate. High ALT levels should be encouraged to prevent liver damage (this damage can occur because of toxins, not enough oxygen, inflammation, disorders of metabolic and increasing mitochondria membrane permeability). In accordance with the present results, goats were fed non-conventional energy had mean normal ranges of AST and ALT. Tibbo *et al*. (2008) recorded that the mean normal serum enzymes levels ranged from 14.0 - 20.2 IU/L for ALT from 43.2 - 49.3 IU/L for AST in goats. Furthermore, beside the normal ranges of AST and ALT activities, serum of goats indicated a good nutritional status and their livers function were in a normal pathological condition (Anwar *et al*., 2012 and Li *et al*., 2012). At all events, Oler and Głowińska (2013) described that a risk of higher ALT and AST was associated with liver morbidness and liver deterioration. Also, these authors explained that liver disease had been associated with body fat distribution, plasma glucose, lipid, bilirubin concentrations and impairment of kidney function.

CONCLUSION

From these results, it could be concluded that types of inexpensive non-conventional energy supplement to poor diet positively improved liver function and increased body weight of goats and born kids. The dairy goats fed rations combined with 2.5% PF and 2.5% CSL seems to be more effective than either 5% PF or 5% CSL or control on production and reproduction performances.

REFERENCES

Anwar, M. M., Ramadan, T. A. and Taha, T. A. (2012). Serum metabolites, milk yield, and physiological responses during the first week after kidding in Anglo-Nubian, Angora, Baladi, and Damascus goats under subtropical conditions. J. Anim. Sci., 90:4795-4806.

AOAC (2007). Association of Official Analytical Chemists. Official Methods of Analysis. 19th Edition. Washington DC, USA.

Bernal-Santos G., Perfield J., Barbano I., Bauman D. and Overton T. (2003). Production responses of dairy cows to dietary supplementation with conjugated linoleic acid (CLA) during the transition period and early location. J. Dairy Sci., 86: 3218-3228.

Bernard L., Rouel J., Leroux C., Ferlay A. and Faulconnier Y. (2005). Mammary lipid metabolism and milk fatty acid secretion in Alpine goats fed vegetable lipids. J. Dairy Sci., 88: 1478-1489.

Bradley, R. L., Arnold, E., Barbano, D. M., Semerad, R. G., Smith, D. E. and Vines, B. K. (1992). Chemical and physical methods. In: Marshall, R.T. (Ed.), Standard Methods for the Examination of Dairy Products. American Public Health Association, Washington, D C, USA. pp: 433–531.

Chay-Canul, A. J., Ayala-Burgos, A. J., Kú-Vera, J. C., Magaña-Monforte, J. G. and Tedeschi, L. O. (2011). The effects of metabolizable energy intake on body fat depots of adult Pelibuey ewes fed roughage diets under tropical conditions. Tropical Animal Health and Production. 43: 929-936.

Chilliard Y., Ferlay, A., Rouel, J. and Lamberet, G. A. (2003). Review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis. J. Dairy Sci., 86:1751–1770.

Cieslak, A., Kowalczyk, J., Czauderna, M., Potkanski, A. and Szumacher-Strabel, M. (2010). Enhancing unsaturated fatty acids in ewe's milk by feeding rapeseed or linseed oil. Czech. J. Anim. Sci., 55: 496–504.

Dirandeh, E. Towhidi, A., Zeinoaldini, S. Ganjkhanlou, M., Ansari Pirsaraei, Z. and Fouladi-Nashta, A. (2013). Effects of different polyunsaturated fatty acid supplementations during the postpartum periods of early lactating dairy cows on milk yield, metabolic responses, and reproductive performances. J. Anim. Sci., 91(2): 713-721.

El-Nour, H. H. M., Nasr, S. M. and Hassan, W. R. (2012). Effect of calcium soap of fatty acids supplementation on serum biochemical parameters and ovarian activity during out-of-the-breeding season in crossbred ewes. The Scientific World Journal. 2012: 1-7.

El-Sanafawy, H. A. (2008). Performance of goats fed on rations containing whole sunflower seeds. M. Sc. Thesis, Fac. Agric., Kafer El-Sheikh Univ., Egypt.

El-Shafie, M. H. and El-Ashmay, T. (2010). Performance of goats fed rations contained whole sunflower seeds. Egyptian Journal of Sheep & Goat Sciences. 5 (2): 45- 52.

El-Shahat, K. H. and Abo-El Maaty, A. M. (2010). The effect of dietary supplementation with calcium salts of long chain fatty acids and /or I-carnitine on ovarian activity of Rahmani ewes. Anim. Reprod. Sci.,117: 78-82.

Espinoza, J., Ramirez-Godinez, J., Simental, S., Jimenez, J., Ramirez, R., Palacios, A. and Lun, R. (1997). Effects of calcium soaps of fatty acids on serum hormones and lipid metabolism in Pelibuey ewes. Small Rumin. Res., 26: 61-68.

Friedewald, W. T., Levy, R. I. and Fredrickson, D. S. (1972). Estimation of the concentration of low density lipoprotein in plasma, without use of the preparative ultracentrifuge. Clin. Chem., 18: 499-502.

Gantner, V. and Kompan, D. (2012). Milk yield, milk composition and somatic cell count of dairy goats given n-3 unsaturated fatty acids diet supplement. Acta Veterinaria (Beograd), 62 (2-3): 281-287.

Ghattas, T. A. and Nasra, A. A. (2010). Effects of rumen-protected polyunsaturated fatty acid on some reproductive performance in out of breeding season ewes," Egyptian Journal of Basic and Applied Physiology, 9: 291–305.

Hafez, Y. H., Khalifa, E. I., El-Shafie, M. H., Abdel Khalek, T. M. M., Ahmed, M. I. and Shehata, E. I. (2011). Effect of energy flushing pre-mating and during mating season on production and reproduction performance of Zaraibi goats. Egyptian Journal of Sheep & Goat Sciences, 6 (1): 7-14.

Hassan, T. M., Ibrahim, M., Itman, K. and Abdel-Hai, I. (2012). Productive and reproductive performance of Zaraibi goats fed different types of protected fat. The 3rd Scientific Conference for Animal Nutrition, Sharm El-Sheikh, 14-17 Feb.,24(2):312-219.

Hosam, T. (2011). Effects of varying levels of protected fat on performance of Shami goats during early and mid lactation. Turk. J. Vet. Anim. Sci., 35(2): 67-74.

Hu, J., Zhang, Z., Wen-Jun, S. and Azha, S. (2010). Cellular cholesterol delivery, intracellular processing and utilization for biosynthesis of steroid hormones. Nutrition & Metabolism, 7 :(47) 2-25.

Hutchinson, I. A., Hennessy, A. A., Waters, S. M., Dewhurst, R. J., Evans, A. C., Lonergan, P. and Butler, S. T. (2012). Effect of supplementation with different fat sources on the mechanisms involved in reproductive performance in lactating dairy cattle. Theriogenology, 78(1):12-27.

Junior, J. E. F., Renno, F. P., Santos, M. V., Gandra, J. R., Filho, M. M. and Venturelli, B. C. (2010). Productive performance and composition of milk protein fraction in dairy cows supplemented with fat sources. Revista Brasileira de Zootecnia, 39: 845-852.

Karikari, P. K. and Blasu, E.Y. (2009). Influence of nutritional flushing prior to mating on the performance of West African Dwarf goats mated in the rainy season. Pak. J. Nutr., 8(7):1068-1073.

Li, G., Shi, W., Hug, H., Chen, Y., Liu, L. and Yin, D. (2012). Nonalcoholic fatty liver disease associated with impairment of kidney function in nondiabetes population. Biochem. Med. (Zagreb). 22(1):92-99.

Liel, A. Z. A., Abd El-Rahman, H. M. A. and El-Nour, H. H. M. (2010). Laparoscopic examination of ovarian activity and some metabolic changes in ewes supplemented with protected fat and growth hormone during estrous cycle. Egyptian Journal of Basic and Applied Physiology, 9: 307–323.

MAFF (1976). Energy Allowances and Feeding Systems for Ruminants. Ministry of Agriculture, Fisheries and Food. Technical Bulletin 33. London, Her Majesty's Stationary Office, UK.

Martinez, L. M. A., Palacios, C., Vivar-Quintana, A. M. and Revilla, I. (2010). Effect of the addition of calcium soap to ewes' diet on fatty acid composition of ewe milk and subcutaneous fat of suckling lambs reared on ewe milk. Meat Sci., 84: 677-683.

Min, B. R., Hart, S. P., Sahlu, T. and Satter, L. D. (2005). The effect of diets on milk production and composition and on lactation curves in pastured dairy goats. J. Dairy Sci., 88:2604–2615.

Mostafa, T. H., Etman, K. E. I., Abd El-Hamid, A. A. and Ahmed, M. I.(2012). Studies on nutritional and economical models under different production system: 1. Effect of fatty acids of calcium soap on productive performance of dairy goats. Egyptian J. Nutrition and Feeds, 15 (1): 225-235.

NRC (2007). Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. National Research Council of the National Academies, National Academies Press, Washington, D.C., U.S.A.

Oler, A. and Głowińska, B. (2013). Blood chemistry, thyroid hormones, and insulin serum content in bulls fed a ration limited in energy. Turkish Journal of Veterinary and Animal Sciences, 37: 194-199.

Otaru, S. M., Adamu, O. W., Ehoche, O. W. and Makun, H. J. (2011). Effects of varying the level of palm oil on feed intake and milk yield and composition and postpartum weight changes of Red Sokoto goats. Small Rumin. Res., 96:25-35.

Paengkoum, S., Metha, W., Chalong, W. and Ngarmnit, N. (2010). The effect of roughage and urea solution infusion levels on ruminal NH_3-N concentration and nutrient digestibility in beef cattle and swamp buffaloes. Silpakorn Science & Tech. J., 4 (1): 47-55.

Pala, A. and Koyuncu, E. (2007). Effects of short periods of frequent milking on the persistency of milk yield and SCS in Turkish Saanen goats. Animal Science Journal, 78: 400-406.

Roger, G., Pambu, R., Webb, E.C. and Mohale, L. (2011). Differences in milk yield and composition of different goat breeds raised in the same environment in South Africa. 6 (5): 237-242.

Rosales-Nieto, C. A., Gamez-Vazquez, H. G., Gudino-Reyes, J., Reyes-Ramirez, E. A., Eaton, M., Stanko, R. L., Meza-Herrera, C. A. and Gonzalez-Bulnes, A. (2011). Nutritional and metabolic modulation of the male effect on the resumption of ovulatory activity in goats. Anim. Prod. Sci., 51(2): 115-122.

Safari, J., Kifaro, G.C., Mushi, D.E., Mtenga, L. A., Adnøy, T. and Eik, L.O. (2012). Influence of flushing and season of kidding on reproductive characteristics of Small East African goats (does) and growth performance of their kids in a semi arid area of Tanzania. African Journal of Agricultural Research, 7(35): 4948-4955.

Safari, J., Mushi, D. E., Kifaro, G. C., Mtenga, L. A. and Eik, L. O. (2011). Seasonal variation in chemical composition of native forages, grazing behaviour and some blood metabolites of small East African goats in a semi-arid area of Tanzania. Anim. Feed Sci. Technol., 164(1-2): 62-70.

Sampelayo, M., Fernandez, J., Ramos, E., Hermoso, R., Gill, E. F. and Boza, J. (2006). Effect of providing a polyunsaturated fatty acid-rich protected fat to lactating goats on growth and body composition of suckling goat kids. J. Anim. Sci., 82, 337-344.

Santos, J. E., Bilby, T. R., Thatcher, W. W., Staples, C. R. and Silvestre, F. T. (2008). Long chain fatty acids of diet as factors influencing reproduction in cattle. Reprod. Domest. Anim., 43(2): 23-30.

Santos, V. L. F., Ferreira, M. A., Guim, A., Silva, F. M., Urbano, S. A., and Silva, E. C. (2012). Protein sources for crossbred dairy cows in the semiarid. Revista Brasileira de Zootecnia, 41(10):2272-2278.

Sanz Sampelayo, M. R., Pe´rez, L., Martı´n Alonso, J. J., Gil, E., F. and Boza, J. (2002). Effects of concentrates with different contents of protected fat rich in PUFAs on the performance of lactating Granadina goats I. Feed intake, nutrient digestibility, N and energy utilisation for milk production. Small Rumin. Res., 43:133–139.

SAS (2009). SAS/STAT® 9.2 User's Guide, 2nd ed. SAS Institute Inc, Cary, NC, USA.

Shittu, O. O., Smith, O. F. and Osinowo, O. A. (2011). Roughage to concentrate ratio on milk secretion rate in goats. African Journal of Agricultural Research. 6(12): 2883-2888.

Sultana, S., Khan, M. J., Hassan, M. R. and Khondoker, M. A. M. Y. (2012). Effects of concentrate supplementation on growth, reproduction and milk yield of Black Bengal goats (*Capra hircus*). The Bangladesh Veterinarian, 29(1): 7–16.

Tibbo, M., Jibril, Y., Woldemeskel, M., Dawo, F., Aragaw, K. and Rege, J. E. (2008). Serum enzymes levels and influencing factors in three indigenous Ethiopian goat breeds.Trop. Anim. Health Prod., 40(8):657-66.

Titi, H. H. and Fataftah, A. (2013). Effect of supplementation with vegetable oil on performance of lactating Awassi ewes, growth of their lambs, and on fatty acid profile of milk and blood of lambs. Archiv. Tierzucht., 56: 1-45.

Titi, H. H., Alnimer, M., Tabbaa, M. J., Lubbadeh, W. F. (2008). Reproductive performance of seasonal ewes and does fed dry fat during their post-partum period. Livest. Sci., 115(1):34-41.

Titi, H. H., Hasan, Y. L.,Al-Ismail, K., Zakaria, H., Tabbaa, M. J., Abdullah, A.Y. and Obeidat, B. S. (2011). Response of Shami goats and kids to variable levels of soyabean or sunflower oils in diets. Journal of Animal and Feed Sciences, 20: 493–508.

Tyrell, H. F. and Reid, J. T. (1965). Prediction of energy value of cow's milk. J. Dairy Sci., 48:1215-1223.

Wadhwani, K. N., Parnerkar, S., Saiyed, L.H. and Pate, A. M. (2010). Feedlot performance of weaner lambs on conventional and non conventional total mixed ration. Indian J. Anim. Res., 44(1): 16 – 21.

Yusuf, A. M., Olafadehan, O. A., Obun, C. O., Inuwa, M., Garba, M. H. and Shagwa, S. M. (2009). Nutritional evaluation of sheabutter fat in fattening of Yankasa sheep Nutritional Evaluation of Sheabutter Fat in Fattening of Yankasa Sheep. Pakistan Journal of Nutrition, 8 (7): 1062-1067.

Zhang, R., Mustafa, A. and Zhao X. (2006). Effect of feeding oilseeds rich in linoleic and linolenic fatty acids to lactating ewes on cheese yield and on fatty acid composition of milk and cheese. Anim. Feed Sci. Tech., 127: 220-233.

الملخص العربى

إضافة مصادر طاقة غير تقليدية للعلائق لتحسين الأداء الإنتاجى والتناسلى للماعز الزرايبى الحلاب

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الهدف من الدراسة التعرف على أثرإضافة مصادر طاقة غير تقليدية للعلائق الأساسية على تحسين الأداء الإنتاجي والتناسلى للماعز الزرايبى الحلابة. وقد استخدم فى هذا العمل أربع أنواع من العلائق كالتالي: T1 تتكون من 60٪ مخلوط مركزات اعلاف (CFM)، بالإضافة إلى 40٪ قش الأرز (RS)، T2 تتكون من 50% CFM + 45% RS +5 % دهن محمى (PF) من ® Megalac، T3 تتكون من 50 ٪ CFM + 45% RS + 5% السائل المتخلف عن انتاج النشا من الذره (CSL)، T4 تضم 50٪ CFM +45% RS + 2.5 %PF + 2.5 %CSL. وقدمت العلائق قبل 28 يوما من موسم التكاثر لعدد اثنين وتسعين ماعز زرايبي (ن = 23 لكل مجموعة). كان متوسط وزن الجسم 35,92 كجم والعمر < 30 شهرا. وقد تم تقدير الوزن خلال مراحل الحمل، والأداء التناسلى، إنتاج وتركيب الحليب خلال الرضاعة والحليب وتركيب الدم خلال الرضاعة والحليب. و يمكن تلخيص النتائج المتحصل عليها على النحو التالى: الماعز التى تغذت T2 و T4 أظهرت أعلى فروق معنوية (عند المستوى 0.05) خلال المراحل المختلفة مقارنة مع T1 و T3. والعليقة T2 و T4 حققت أفضل أداء تناسلى بمعنوية (5%) من T1 و T3. وكان معدل الخصوبة أعلى مع العلائق T4 و T2 T3 مقارنة بالعليقة T1 حيث كانت 200,00٪، 186,96٪، 156,52٪ ، 130,43٪ على التوالي. وأشارت الدراسة إلى تحسن فى لبن الرضاعة 40,85٪، 22,68٪ ، 52,11٪ وتحسن فى انتاج اللبن بنسبة 24,21٪، 12,51٪ ، 33,44٪ مع T2، T3 و T4 على التوالي. تم الحصول على أفضل تركيبة للحليب مع T2 و T4 مقارنة مع T1 و T3.وكان تركيز جلوكوز الدم قد تغير قليلا دون فروق ذات دلالة إحصائية بين الماعز T2، T3 و T4 مقارنة بالماعز T1 أثناء الرضاعة وفترات الحليب. والتحليلات البيوكيميائية للدم مثل الدهون الثلاثية والكوليسترول، LDL، HDL، AST و ALT كانت معنوية فى الفروق بين علائق الطاقة التقليدية مقارنة بعليقة المقارنة. من هذه النتائج نستنتج أن تغذية الماعز الزرايبي الحلاب على العلائق التي تحتوي على مصادر الطاقة غير التقليدية الرخيصة وخصوصا عند الجمع بين CSL وPF يتحقق تحسين فى وزن الماعز اثناء مراحل الحمل والأداء التناسلى وكمية البن وتركيبه اثناء الرضاعة والحليب ومقاييس الدم للماعز الزرايبى الحلاب.