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# IMPACT OF NON-CONVENTIONAL ENERGY SOURCES IN RATION ON PRODUTIVE AND REPRODUTIVE PERFORMANCE OF EWES

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## ABSTRACT

The present work aimed to define the influence of the non-conventional energy sources added to the ration on productive and reproductive performance of ewes. The variety of energy sources such as basal conventional energy (BCE) and admixture of unconventional energy (UCE) protected fat (PF) and corn steep liquor (CSL) were investigated. Ten healthy and mature Rahmani ewes were divided into two groups (n=5). Ewes in 1st group fed BCE contained gross energy (GE) at a level of 300.21 cal/100 gm diets as 60% concentrate feed mixture (CFM) + 40% rice straw (RS). While, 2nd group nourished UCE which given ewes GE at a level of 332.46 cal/100 gm diets (55% CFM + 40% RS + 2.5% PF + 2.5% CSL). All ewes were received both BCE and UCE at 21 days pre-mating season and continued until lambing. The changes in body weight, fertility rate and parity pattern of ewes fed BCE and UCE were measured. Progesterone ($P_4$) profile was also determined during gestation and number of fetuses. Blood metabolites were investigated during different stages of gestation.

The obtained results showed that ewes given UCE had slight ($P>0.05$) improvement in body weight but at prepartum they had significantly ($P<0.05$) higher live body weight compared with ewes received BCE energy. Ewes fed UCE showed improvement prolificacy (100%) and parity patterns as twins rate (40.00%) compared to ewes received BCE that have feeble prolificacy (83.33%) and twins rate (20.00%). Progesterone ($P_4$) in ewes fed UCE had higher ($P<0.05$) levels than ewes fed BCE during different stages of gestation. Fetus numbers emphasized that the level of $P_4$ in ewes carrying two fetuses increased ($P<0.05$) compared to ewes carrying just one fetus throughout gestation. The blood metabolites of ewes fed UCE showed higher ($P<0.05$) levels of total proteins, albumin, globulin, cholesterol, glucose, calcium and phosphorus than ewes fed BCE. However, serum creatinine, triglycerides and urea-N in ewes fed UCE were insignificantly higher than those of BCE ewes. This study concluded that unconventional energy is recommended to be included in farm animal diets at moderate amounts. Maintaining normal range for most commonly used serum biochemical parameters during different reproductive stages should considered in farm management strategy.

***Keywords:*** *Ewes, non-conventional energy, number of lambs born, blood components.*

## INTRODUCTION

One of the ways to increase mutton production is to increase the number of lambs born of ewe. This can achieve by inducing multiple births or acquiring two lamb crops every year. For this reason, foetal growth is a complex process that involves the interaction of maternal, placenta and fetus environments. The growth and development of fetus depends on nutrients. The primary nutrient consideration for optimum reproductive performance of sheep is energy. Freetly and Leymaster (2004) concluded that approximately 60% of energy dissipated during pregnancy can be contributed to the gravid uterus and the remaining 40% invested to maternal metabolism. Elegant studies on ewes had demonstrated that energy affects directly and indirectly both physiological and reproductive performances. Energy strategy may be used to enhance ovulation rate and prolificacy. Ewes in good body condition at pregnancy stages and lambing time can tolerate minimal body weight changes before and after lambing. Moreover, ewes during gestation period require energy for maintenance of the developing fetuses, supporting tissues of pregnancy (placenta, fluids and udder development, etc.) and increasing ewes' body tissues for the upcoming lactation. Otherwise, the effects of overfeeding with high-energy diets are well known to stimulate follicular development and increase ovulation rate (Saunders *et al.,* 2010). Nevertheless, ewes' welfare using short-term of energy "termed as flushing" can improve ovulation rate and litter size mainly in small ruminants. Many authors have demonstrated that blood progesterone ($P_4$) concentration can be influenced by energy feed intake (Dorniak *et al.,* 2012). In the research of Inskeep *et al.* (2009) they concluded that blood $P_4$ concentration showed negative fluctuations on day 20 of gestation which was an indicator of embryo loss. Complete losses were greater between 25$^{th}$ and 85$^{th}$ days of pregnancy of ewes. In this context, Ataman *et al.* (2013) revealed that blood $P_4$ concentration tended to be higher in sheep carrying two fetuses than those conceived one fetus. Therefore, selection of feeding is based on the mean embryonic survival that provides an effective way to improve fetus growth. Manthou *et al.* (2014) indicated that basic nutrition provides benefit of health and presence of physiologically active components. Generally, many authors proclaimed that addition of unconventional energy sources to feedstuffs caused deficiency in amount of concentrate feed (Hutchinson, *et al.,* 2012), dependable for animals nutrition (Mostafa, *et al.,* 2012) and improvement of productive and reproductive performance (Behery *et al.,* 2014).

The aim of the present work was to study the possible improvement of productive and reproductive performances of Rahmani ewes via unconventional energy sources.

## MATERIALS AND METHODS

### *Experimental animals*

The investigation was carried out at El-Serw Experimental Research Station belonging to Animal Production Research Institute (APRI), Ministry of Agriculture, Egypt. Ten Rahmani ewes had 47.00±5.70 months of age and 46.90±2.18 kg live body weight were used in the present work. Ewes were raised in semi-open pens and consumed the maintenance requirements of ewes according to NRC (2007). Furthermore, before breeding season ewes were treated against internal and external parasites and dipped against ticks and fleas.

### *Experimental design*

Ten ewes were randomly assigned into two groups (n=5). The first group was nourished basal conventional energy (BCE), while second group was received unconventional energy (UCE). The BCE contained 60% concentrate feed mixture (CFM) + 40% rice straws (RS). While, UCE consisted of 55% CFM + 40% RS +2.5% protected fat (PF) +2.5% corn steep liquor (CSL). Both BCE and UCE were presented gross energy levels of 300.21 and 332.46 cal/100 gm diets. They offered 21 days pre-mating season up to parturition. Ewes displayed estrous cycle from either BCE or UCE groups tupped by the same fertile ram at 12 hours of heating onset. The experimental diets were prepared and adjusted daily by mixing basal diet with non-conventional energy materials and presented to ewes twice a day. Fresh water and salt templates presented free all experimental period to all ewe groups. The chemical compositions of BCE and UCE energy were analysed according to AOAC (2007) and results shown in Table 1.

### *Productive and reproductive performance:*

#### *Productive performance:*

Body weight (wt) was recorded at start of the experiment, pre- and post-tupping seasons, pre- and post-partum, birth weight and gestation length (days).

**Table 1. Chemical composition of energy diet.**

| Items | Experimental energy | |
|---|---|---|
| | BCE | UCE |
| Organic matter (OM) | 87.08 | 90.53 |
| Crude protein (CP) | 14.46 | 14.58 |
| Crude fiber (CF) | 15.59 | 12.74 |
| Ether extract (EE) | 2.85 | 4.26 |
| Nitrogen free extract (NFE) | 54.18 | 58.95 |
| Ash | 12.92 | 9.47 |
| *GE | 300.21 | 332.46 |

*GE= Gross energy (cal/ 100 gm diets), it determined by the formula according to Ramin *et al.* (2010) as CP% × 4 + EE% × 9 + NFE% × 4.

***Reproductive performance:***

After tupping, ewe that passed another oestrous cycle without showing heating (using scout ram) accounted gravid. Then, reproductive performance was calculated as conception rate (number of maternal conceived / tupping maternal), fertility (number of maternal lambed / tupping maternal), fecundity (number of lambs born / tupping maternal) and prolificacy (number of a live lambs born / lambing maternal).

Parity patterns were calculated as single birth rate (number of maternal lambing single/ number of maternal lambed) and twins birth rate (number of maternal lambing twins/ number of maternal lambed).

***Progesterone ($P_4$) profiles and fetus numbers:***

Blood samples were obtained from the jugular vein and drawn into sterile test tube at ovulation time (24 hours) with the start of estrus (day 0). Afterwards, $P_4$ was checked at 20, 40, 60, 80 and 100 days of gestation. The blood serum was separated by centrifuging at 3000 g for 20 min and then serum was harvested by pipette and stored at −20°C until assayed for progesterone.

The $P_4$ concentration accomplished during pregnancy period was used to deduce fetus numbers of ewes exhibited either single or twin lambing after parturition proven. The blood $P_4$ concentration was estimated by RIA using ELISA kit (Human Ge-sellschaft, Biochemical Diagnostica GmbH and Germany).

***Blood components:***

In the morning, before feeding, blood samples were collected (5 samples / energy group) at three stages of gestation. Thereafter, blood was sampled at 5, 11 and 20 weeks of pregnancy which represent early, mid and late stages, respectively. Blood samples were collected without anticoagulant and centrifuged at 3500 g for 15 min and the serum was stored at −20°C for further chemical analysis. Then, there have been found the immunity function (total protein and albumin then, globulin calculated as total protein - albumin), lipid profiles (cholesterol and triglyceride), pancreatic function (glucose), kidney function (creatinine and urea-N) and minerals concentrations (calcium and phosphorus). The levels of blood biochemical were assayed using chemical commercial kits (Diamond Diagnostics, Egypt).

***Statistical analysis:***

Date was statistically analysed using Social Sciences (SPSS software, 2011, Version 20) program. Differences among means were tested using Duncan's New multiple-range tests of the same later program. All statements of significance based on a probability of $P<0.05$.

## RESULTS AND DISCUSSION

***Productive activity:***

The productive parameters are summarized in Table (2). Differences between body weight of ewes fed BCE or UCE diets were insignificant during start work (kg), pre-tupping season (kg), post-tupping season (kg), post-partum (kg), at birth (kg) and gestation length (days), while significantly ($P<0.05$) higher for ewes fed UCE (59.40 kg) than BCE (55.80 kg) during per-partum (kg). It has been observed that deficient energy nutrition during pregnancy induces low weight of offspring at birth, as well as, lower body weight gain for females. Ramirez-Vera *et al.* (2011) reported that insufficient energy nutrition during pregnancy induces emaciated offspring weight, little colostrum and suckling milk production. Accordingly, Ólafsdóttir *et al.* (2012) noticed that improving body weight of ewes in this critical period (prepartum) not only affected the growth of the developing fetus, but also the ability of the ewe to supply lamb with adequate amount of colostrum and milk postpartum. On the other hand, several authors have been reported that energy ameliorate feed intake of small ruminants (Hassan *et al*. 2012 and Khalifa *et al.*, 2013). Furthermore, UCE has been given better ($P>0.05$) lambing weight than those lambed with feeding BCE which attributed to energy supplemented to ration. This mentioned study agree with that carried out by Radunz *et al.* (2011) who observed that ewes generally lost weight during pregnancy, lactation or gain weight at a very low rate depending on their plane of energy in nutrition. Further, these authors reported that energy intake can affect fetal growth and stimulates release of glucose, thereby potentially affecting nutrient supply to the gravid uterus. Moreover, non-significant differences were observed on gestation length (151.00 and 151.60 days) when ewes supplied BCE or UCE, respectively. Thus, duration length in this experiment is in agreement with duration range (144 - 155 days) of most sheep breeds (Gootwine, 2013).

The reproductive parameters are shown in Table (3). The reproductive performance of ewes received UCE or BCE diet were insignificantly differed. In addition, the number of dams born single and single rate (%) of ewes fed UCE diet was insignificantly lower than those ewes nourished BCE diet. Ewes received UCE could regulate sexual hormonal secretion and appeared positive reproductive activity. It is obvious from previous studies that mechanism of secretion of a major sexual hormone such as Luteinizing hormone (LH), that stimulate ovary and occurred ova ovulation, regulated partially by indirect way from the pituitary and hypothalamic gland. These findings confirmed by Radunz (2009) who explained that fat supplementation might increase glucose production through increasing propionate production. Consequently, the increase in glucose may have a positive effect on LH release. Furthermore, the same later author elucidated that glucose provide great signal to the hypothalamic pituitary that control system to secrete more LH. Otherwise, the development of nutrition programs emphasize that energy supplementation might improve ration composition to maintain or enhance reproductive efficiency (Pescara *et al.*, 2010). In addition, energy balance in diet has a significant influence on multiple reproductive functions (Evans and Anderson, 2012). In this context, most studies about the influence of positive energy balance (PEB) on reproductive efficiency have been performed on goats (Khalifa *et al.*, 2013) and ewes (Alkass *et al.*, 2014). Generally, dietary energy supplementation (by glucose and fructose) causes an array for the metabolic effects on reproductive activity where increases in number of carbohydrates have been identified in cervical mucus. These compounds appear to be the major free sugars in uterine flushed from the ewes. Futhermore, insulin concentration which play an essential role in mediating increased follicular growth, by insulin-growth factor I (IGF-I) and increased concentration of growth hormone (GH), during the postpartum which develop an increase in the accumulation of follicular fluid (Rahbar *et al.*, 2014).

**Table 2. Productive performance of ewes fed either BCE or UCE diets.**

| Items | Energy types | |
|---|---|---|
| | **BCE** | **UCE** |
| **Mean wt. at start work, kg** | 46.80±1.07 | 47.00±1.00 |
| **Mean wt. pre- tupping season, kg** | 48.80±1.06 | 49.40±1.08 |
| **Mean wt. post- tupping season, kg** | 50.40±1.67 | 52.00±1.05 |
| **Mean wt. prepartum, kg** | 55.80±1.16$^{b}$ | 59.40±1.03$^{a}$ |
| **Mean wt. postpartum, kg** | 50.80±1.83 | 51.00±1.70 |
| **Mean wt. of lambs at birth, kg** | 3.00±0.55 | 3.90±0.56 |
| **Mean of gestation length, day** | 151.00±2.03 | 151.60±0.75 |

a, b : Means in the same row with different superscripts are significantly different ($P<0.05$).
Reproductive performance of ewes:

**Table 3. Reproductive performance of ewes fed either BCE or UCE diets.**

| Items | Energy types | |
|---|---|---|
| | **BCE** | **UCE** |
| No. of maternal tupping | 5.00 | 5.00 |
| No. of maternal conceived | 5.00 | 5.00 |
| Conception rate (%) | 100 | 100 |
| No. of maternal lambing | 5.00 | 5.00 |
| Total no. of lambing | 6.00 | 7.00 |
| No. of a live lambs at birth | 5.00 | 7.00 |
| Fertility rate (%) | 100 | 100 |
| Fecundity (%) | 100 | 100 |
| Prolificacy (%) | 83.33 | 100 |
| **Parity patterns**: | | |
| No. of maternal born single | 4.00 | 3.00 |
| Single rate (%) | 80.00 | 60.00 |
| No. of maternal born twins | 1.00 | 2.00 |
| Twins rate (%) | 20.00 | 40.00 |

***Progesterone ($P_4$) profiles***

The following graph (Fig. 1) show that ewes fed UCE significantly ($P<0.05$) had higher progesterone in pregnant ewes than those nourished BCE. At the start, on 0 day after tupping, the $P_4$ concentration did not show any significant difference between ewes fed BCE and UCE energy. UCE kept a little, but significant, elevation in P4 level compared to BCE ewes by progress of gestation. Meanwhile, the curve lines show a clear positive relationship between $P_4$ levels and advancing stage of pregnancy. Hence, energy material addition had interpreted positively the reproductive function at several important tissues specially ovary and uterus. Moreover, dietary energy supplementation increases circulating concentrations of cholesterol, progesterone and increased lifespan of corpora lutea (CL). These observations are supported by the results of Lopes *et al.* (2011) who noticed that cholesterol serves as a precursor for the synthesis of progesterone by ovarian luteal cells; also it could be decided that $P_4$ prepares the uterus for implantation of the embryo and helps maintaining pregnancy. In addition, Reis *et al.* (2012) reported that adding protected fat (PF) increased serum $P_4$ concentration and tended to increase serum insulin concentration. Subsequently, the same later authors found that longer periods of PF supplementation was required to potentially increase circulating concentrations of $P_4$. On the other hand, Alizadeh *et al.* (2012) suggested that synthesis of steroids in luteal tissues depends on the availability of cholesterol, so increasing of cholesterol can augment progesterone production in follicular and luteal cellules by increasing the availability of sterol precursor. At all events, blood progesterone is one of the most important factors to be observed for its importance in maintaining pregnancy. Researchers recognized that the physiological mechanism responsible for increasing progesterone concentration in blood serum is the increase of its pioneer source likely cholesterol (Moriel *et al.,* 2014).

***Pregnancy diagnosis:***

Progesterone concentration was higher for ewes lambing twins than single ($P<0.05$) (Fig. 2). In spite of the belated prediction of fetal number by using $P_4$ concentration method, it seems to be cheap and practical and it is an important criterion for better reproductive management in livestock before trimester of gestation. Accordingly, Yotov (2007) reported that measuring number of fetuses in sheep breeds through progesterone method could performed later (60$^{th}$ day) than that by ultrasonography method (40$^{th}$ day). He reported that early pregnancy diagnosis is crucial to shorten the lambing interval through enabling the farmer to identify open animals to treat and/or rebreed them at the earliest opportunity. On the other hand, Kalkan *et al.* (1996) confirmed that there was a positive relationship between the number of fetuses and the mean progesterone concentrations. Also, Karen *et al.* (2001) reported that progesterone concentration was used to indicate the presence or absence of functional corpora lutea and fetal number predictions, so, progesterone concentration was significantly higher in ewes carrying two fetuses (19.2 ng/mL) and three fetuses (29.9 ng/ml) than those carrying one (9.2 ng/mL) fetus. Furthermore, Nessim *et al.* (2009) summarized that $P_4$ level significantly increase in ewes with single lamb than those with twin lambs at days 10 and 20 of pregnancy then, higher $P_4$ level was detected in ewes carrying twins. The diameter of corpus luteum (CL) and $P_4$ concentration of pregnant ewes bearing a single fetus or twin fetuses were higher than that found in non-pregnant ewes. This notion was defined by Gür *et al.* (2011) who indicated that $P_4$ concentration in pregnant ewes bearing twin fetuses was higher than that found in pregnant ewes bearing a single fetus. Additionally, El-Tarabany (2012) found that comparison between ewes conceived twin fetuses showed that most blood $P_4$ values were related with survivability of lambs and the diameter of corpus luteum (CL) on ovaries thence, progesterone concentration was lower (9.34 ng/mL) in single lamb than twin lambs (14.22 ng/mL).

**Fig. 1. Progesterone (P4) profile during gestation of ewes fed either BCE or UCE diets.**

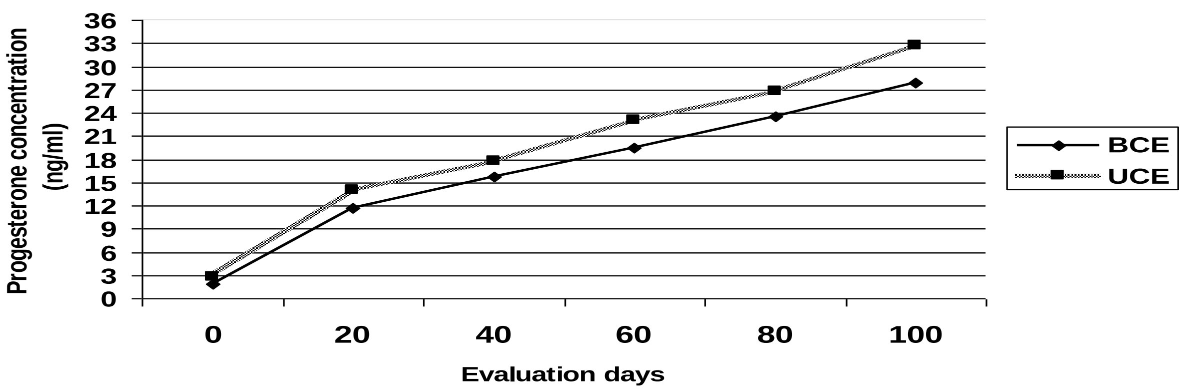
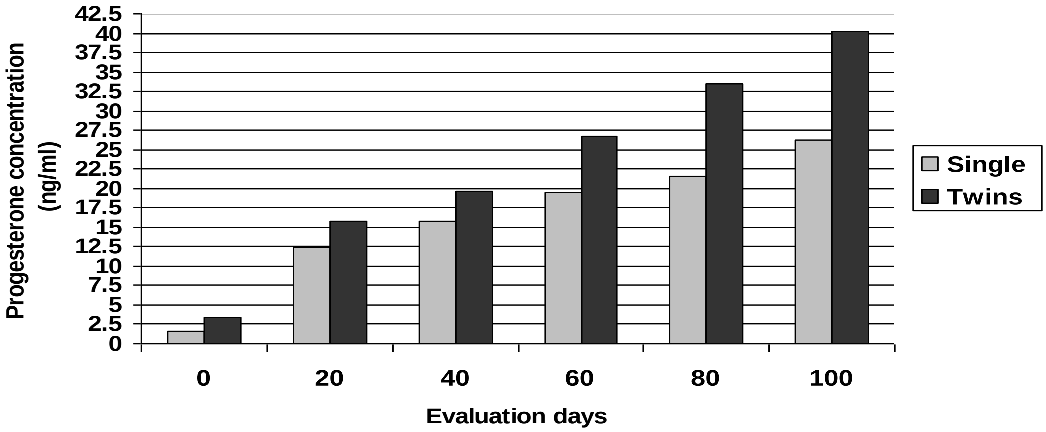


**Fig. 2. Progesterone (P4) concentration in single or twins pergnancy ewes.**




***Blood metabolites:***

The tabulated data in Table (4) indicate that total protein, albumin and globulin (that displayed immunity function) significantly ($P < 0.05$) affected by gestation stages and energy types. The variation of total protein amount during pregnancy stages might related to a decrease in globulin level in blood stream. Accordingly, El-Sherif and Assad (2001) manifested significant increase in serum total protein in early and mid pregnancy stages compared to late gestation which could be due to detract in serum globulin. In the current study, the total protein, albumine and globulin obtained similar diminishing trends to those levels obtained with forwarded gestation stages. Similarly, Hefnawy *et al.* (2010) reported lower immune function in pregnant dams than non-pregnant dams, therefore, pregnancy results in a change in number and function of immune cells in utero that potentially affects fetal survival and uterine defense mechanisms postpartum. In the present study, ewes fed UCE could achieve positive immunity function compared to dams fed BCE energy. In addition, similar trend was observed with the results reported by Ritz and Gardner (2014) who defined that energy diet acknowledged to delay the development of immunity and maintain its function later in lifespan. In addition, energy produced the most convincing evidence of an increased immune response. In the present study, decreasing total protein may be due to increasing foetal growth especially utilization of amino acids in maternal circulation for protein synthesis in the foetal muscles (Lloyd *et al.*, 2012).

Table (5) highlited the mean values of lipid levels and pancreatic function of ewes fed either BCE or UCE energy during different pregnancy weeks. The data indicate that cholesterol and glucose appeared significantly ($P<0.05$) higher in ewes received UCE than ewes fed BCE energy. While, triglyceride concentration was insignificantly higher in ewes received UCE than those fed BCE diet. Furthermore, similar significant ($P<0.05$) variation trend was reported among different stages of pregnancy. In this study, total cholesterol had heightened during early gestation, which might related to responsiveness of the target tissue to low insulin during early pregnancy hence predisposes the ewes to increase cholesterol concentration. This observation is supported by other studies that reported high cholesterol levels at early gestation (El-Tarabany, 2012). Contrariwise, the lowest cholesterol in end of gestation may be associated with reducing glucose level and increasing insulin that elevated cholesterol level. This define is consistent with those of Piccione *et al.* (2009) who reported that total cholesterol concentration were 1.73, 1.60 and 1.45 mmol/l throughout early, mid and late gestation, respectively. However other studies explained that reduction in cholesterol level is probably attributed to the role of ovarian steroidogenesis on declining food intake which is associated with alteration in lipid metabolism and marked reduction in lipogenesis during pregnancy (Papacleovoulou *et al.,* 2013). The decrease in serum triglycerides found in this study during late pregnancy is in accordance with increased concentration of these compounds in the ewes' liver as reported by Mazur *et al.* (2009). Also, the quantity of mobilized fatty acids from adipose tissue depends on the energy balance and has a direct relationship with the severity of the fatty liver. For this reason, fatty acids metabolized by the liver have to be imported via the blood. Therefore, triglyceride secretion is limited from the liver in ruminants when free fatty acid uptake which could be responsible for their particular sensitivity to developing liver steatosis (Piccione *et al.,* 2010). Increasing in triglyceride levels at mid gestation time may be due to insulin, which plays a direct role in adipose tissue metabolism during pregnancy (Deghnouche *et al.,* 2013). Decreasing blood sugar during late pregnancy weeks can be explained by increasing; maternal glucose permeability, consumption by the fetus, physiological stage and diseases (Duehlmeier *et al.,* 2013). The present results indicated that serum glucose concentrations had gradually descended during prepartum period. This observation is supported by Taghipour *et al.* (2010) who found that glucose level changed at day's 45$^{th}$ and 30$^{th}$ prepartum, being 2.45 and 2.14 mmol/l, respectively. Also, the same later authors reported that negative energy balance appears to be related to the glucose demands of the fetal-placental unit in pregnant ewes thus, energy needs of the fetus and placenta are met almost entirely by glucose. However, others indicated that rising glucose level during early pregnancy is associated with stress and increase in secretion of glucocorticoids and epinephrine which stimulate glycogenolysis in the liver (Alameen and Abdelatif, 2012).

Table (6) illustrates the effect of feeding BCE or UCE energy and weeks of pregnancy on the kidney function and some mineral levels. The renal function principally represented by urea and creatinine concentrations, which affected during the different physiological phases of pregnancy in ewes. The serum creatinine level was significantly ($P<0.05$) lower during the 5$^{th}$ and 11$^{th}$ weeks than 20$^{th}$ week of gestation. These results agree with those of El-Tarabany (2012) who stated that creatinine level was 1.27, 1.33 and 1.52 mg/dl during early, mid and late stages of pregnancy, respectively. Thus, it is recognized that during late gestation the foetal maternal circulation, assumes the load of organic waste of the newborn so, the increase in serum creatinine

**Table 4: Total protein, albumine and globulin in blood serum as affected by gestation stages and energy types in ewes.**

| Items | Gestation stages | Energy types | | Overall mean |
|---|---|---|---|---|
| | | BCE | UCE | |
| Total protein (g/dl) | Early | 5.70±0.11 | 6.04±0.27 | 5.87±0.18$^{a}$ |
| | Mid | 5.61±0.09 | 5.88±0.08 | 5.75±0.10$^{b}$ |
| | Late | 5.41±0.07 | 5.64±0.06 | 5.53±0.06$^{c}$ |
| Overall mean | | 5.57±0.06$^{b}$ | 5.85±0.09$^{a}$ | 5.71 |
| Albumin (g/dl) | Early | 3.85±0.06 | 4.02±0.03 | 3.94±0.04$^{a}$ |
| | Mid | 3.72±0.07 | 3.92±0.08 | 3.82±0.08$^{b}$ |
| | Late | 3.55±0.06 | 3.84±0.05 | 3.70±0.05$^{c}$ |
| Overall mean | | 3.71±0.01$^{b}$ | 3.93±0.04$^{a}$ | 3.82 |
| Globulin (g/dl) | Early | 1.85±0.07 | 2.02±0.04 | 1.94±0.06 $^{a}$ |
| | Mid | 1.89±0.07 | 1.96±0.01 | 1.93±0.05$^{a}$ |
| | Late | 1.86±0.02 | 181±0.04 | 1.84±0.02$^{b}$ |
| Overall mean | | 1.87±0.01$^{b}$ | 1.93±0.05$^{a}$ | 1.90 |

a, b, c : Means in the same rows and columns with different superscripts are significantly different ($P<0.05$).

**Table 5: Cholesterol, triglyceride and glucose in blood serum as affected by gestation stages and energy types in ewes.**

| Items | Gestation stages | Energy types | | Overall mean |
|---|---|---|---|---|
| | | BCE | UCE | |
| Cholesterol (mg/dl) | Early | 122.03±0.35 | 123.74±0.38 | 122.89±0.35[a] |
| | Mid | 106.68±0.91 | 110.93±0.95 | 108.81±0.92[c] |
| | Late | 107.39±0.64 | 113.23±0.78 | 110.31±0.71[b] |
| Overall mean | | 112.03±0.62[b] | 115.97±0.71[a] | 114.00 |
| Triglyceride (mg/dl) | Early | 28.36±0.88 | 31.69±1.84 | 30.03±0.52[c] |
| | Mid | 42.99±0.32 | 44.02±0.29 | 43.51±0.31[a] |
| | Late | 37.26±0.36 | 37.84±0.13 | 37.55±0.41[b] |
| Overall mean | | 36.20±0.53 | 37.85±0.74 | 37.03 |
| Glucose (mg/dl) | Early | 72.32±0.27 | 74.95±0.19 | 73.64±0.11 [a] |
| | Mid | 61.90±0.29 | 65.28±0.70 | 63.59±0.51 [b] |
| | Late | 57.85±0.48 | 59.79±0.18 | 58.82±0.34 [c] |
| Overall mean | | 64.02±0.33[b] | 66.67±0.36[a] | 65.35 |

a, b, c : Means in the same rows and columns with different superscripts are significantly different (P<0.05).

levels could be attributed to the development of the foetal musculature (Piccione *et al.,* 2012). Urea is nitrogen-based product secreted from the kidneys, and created by the breakdown of proteins and may be utilized by rumen microbial population to synthesize protein (Kioumarsi *et al.,* 2011). In fact, serum urea concentrations reached little higher (P>0.05) level at early of gestation stages than ewes in mid or late pregnancy status. Contrariwise, the decrease of serum urea-N in mid and late gestation may be associated with either the decline of feed intake due to stress or hormonal changes and it is strictly dependent on the dietary intake of proteins (Taghipour *et al.*, 2010). The slight elevated values of urea during late gestation compared to mid gestation could be ascribed to the high thyroid activity in pregnant dams, which induces an increased protein catabolism (Piccione *et al.,* 2009). In this study, the high requirement for energy by pregnant sheep during their second half of pregnancy led to an increase in urea level which is evident during late pregnancy. Thus, the trivial high values of blood urea-N in the last trimester of pregnancy was observed also by Alameen and Abdelatif (2012). The current results revealed the elevation of urea level measured during early and late gestation, which could be related to enhancement of metabolic activities that induce an increase in protein catabolism. El-Tarabany (2012) revealed that urea-N level in early, mid and late stages of pregnancy were 31.05, 30.10 and 31.50 mg/dl, respectively. Also, in this study the presented results of urea levels were corroborated in dairy cow by Alameen and Abdelatif (2012) who declared that urea concentration varied between 32.13, 30.10 and 31.44 mg/dl in the early, mid and late pregnancy stages, respectively. On the other hand, glucose availability for oxidation is supported by increased catabolism of amino acids at the expense of protein synthesis, thus increasing urea production (Deghnouche *et al.*, 2013).

Serum calcium (Ca) level had significantly (P<0.05) changed in ewes fed BCE or UCE during pregnancy weeks. The decline in serum Ca level in late gestation is related to increase in movement of Ca out of blood, which is not balanced by increase in rate of absorption from gut or mobilization from bone (Khan *et al.*, 2011). Furthermore, Takaya *et al.* (2013) suggested that the decrease in Ca level in late pregnancy might also be associated with haemodilution (an increase in fluid content of blood, resulting in diminuting concentration of formed elements especially in pregnant rats).

**Table 6: Kidney function and some mineral levels in blood serum as affected by gestation stages and energy types in ewes.**

| Items | Gestation stages | Energy types | | Overall mean |
|---|---|---|---|---|
| | | BCE | UCE | |
| Creatinine (mg/dl) | Early | 1.28±0.03 | 1.29±0.04 | 1.29±0.03[c] |
| | Mid | 1.37±0.01 | 1.41±0.02 | 1.39±0.01[b] |
| | Late | 1.54±0.02 | 1.57±0.01 | 1.56±0.02[a] |
| Overall mean | | 1.40±0.04 | 1.42±0.03 | 1.41 |
| Urea (mg/dl) | Early | 32.33±0.33 | 32.63±0.35 | 32.48±0.35 |
| | Mid | 30.40±0.34 | 30.62±0.37 | 30.51±0.34 |
| | Late | 31.08±0.41 | 31.40±0.45 | 31.24±0.42 |
| Overall mean | | 31.27±0.36 | 31.55±0.38 | 31.41 |
| Calcium (mg/dl) | Early | 8.61±0.12 | 8.97±0.02 | 8.79±0.08[a] |
| | Mid | 8.46±0.13 | 8.77±0.09 | 8.62±0.07[b] |
| | Late | 7.74±0.06 | 7.95±0.08 | 7.85±0.05[c] |
| Overall mean | | 8.27±0.11[b] | 8.56±0.07[a] | 8.42 |
| Phosphorus (mg/dl) | Early | 3.83±0.07 | 4.04±0.05 | 3.94±0.06[c] |
| | Mid | 4.29±0.04 | 4.92±0.05 | 4.61±0.05[b] |
| | Late | 4.57±0.10 | 5.02±0.04 | 4.80±0.06[a] |
| Overall mean | | 4.23±0.06[b] | 4.66±0.05[a] | 4.45 |

a, b, c : Means in the same rows and columns with different superscripts are significantly different (P<0.05).

Also, these authors suggested that relative stability of Ca is controlled mainly by a sensitive hormonal mechanism involving hydroxylated metabolites of vitamin D, parathyroid hormone and thyrocalcitonin. Indeed, serum Ca level may be affected by physiological status of animal body's response to environment, as well as, its nutritional conduction (Poppenga *et al.,* 2012). Also, serum phosphorus ion (Pi) level was significantly (P<0.05) lower in early pregnancy than either mid or late pregnancy states. The fluctuation in levels of Pi among gestation weeks may be attributed to an increasing rate of mobilization of phosphorus ion (Pi) out of maternal circulation into the fetus, which was not balanced by increasing the rate of absorption of Pi from the gut or the rate of re-sorption of Pi from the bone of dams (Adriana *et al.,* 2013). At all events, unconventional energy sources that used in rations of small ruminants could have positive effect on body function and could conform normal range of blood metabolites (Behery *et al.*, 2014).

## CONCLUSION

This study helps to recommend the following. Firstly, supporting addition of non-conventional energy in the ration formula of ewes. Secondly, feeding non-conventional energy could offer cheap energy source, which led to decrease feeding cost and safe tool in preventing deficiencies constrain high production of ruminants. Thirdly, if we give consideration for ewes' fertility, conception rate, parity rate and blood metabolites as important reproduction criteria we will advise feeding CFM + RS + non- conventional energy sources rather than feeding CFM+ RS only.

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