NOURISHMENT OF CONVENTIONAL AND NON-CONVENTIONAL ENERGY AND ITS IMPACT ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF ZARAIBI MALE GOATS

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SUMMARY

Four experiments were conducted to evaluate the influence of replacing conventional energy sources as 6o% concentrate feed mixture (CFM) and 40% rice straws (RS) by 5% (DM / kg) of non-conventional energy sources as 2.5% protect fat (PF) and 2.5% corn steep liquor (CSL) + 50% CFM +45% RS on productive and reproductive performance of male goats. In all experiments; the rations were generated metabolic energy at 3213.67 and 3230.22 k cal /kg DM for ME1 (control) and ME2 (trial), respectively. The first experiment using two billy goats aged 32 months and weighed 51-52 kg to indicate fertility rate. At 60 days pre-mating season and continued to end mating season billy goats in control and trial groups were nourished ME1 another ME2, respectively Fertility performance obtained with forty-two similar nanny goats allocated into two groups (n= 21 does / group) . The second experiment managed to welfare eight weaning male kids (N=4 /group) during sexual puberty development; their average initial body weight 15.85 kg and aged 135 days and received ME1 or ME2. During sexual puberty of kids the changing of growth rate, scrotal circumference, testicular volume and testosterone concentration were measured. Then, semen characteristics were investigated when kids reached sexual puberty age. The third experiment used the previous kids to welfare them during growth performance and nourished same energy levels located in ME1 and ME2. During growth rate live body weight, average daily weight gain, dry matter intake, feed conversion ratio, daily water consumption, feed cost and economic efficiency were calculated. The fourth experiment was to investigate blood metabolites at end of kids' growth period. The blood samples were collected from 6 kids (3 kids / energy level) to assay glucose, triglycerides, total cholesterol, HDL and LDL concentrations. The results indicated that 1st experiment could be shown that mature billy goat of ME2 achieved higher conception rate, total number of offspring, fecundity, prolificacy and litter size 95.24%, 44.00, 209.52%, 180.00% and 2.20 than ME1 billy goat 85.71%, 38.00,180.95%, 150.00% and 2.11, respectively. However in 2nd experiment, all sexual puberty stages of kids received ME2 diet had the highest ($P<0.05$) testicular measurements (scrotal circumference and volume), testosterone levels and semen characteristics compared to ME1 energy levels. The 3rd experiment showed ($P<0.05$) changes in dry matter intake, feed conversion ratio and water consumption among kids fed ME1 and . On the contrary, ME2 diet indicated a significantly ($P<0.05$) higher live body weight, average daily weight gain than ME1. In addition, ME2 achieved lower feed cost and greater economic efficiency than kids fed ME1. In the 4th experiment, plasma glucose, triglycerides, total cholesterol and LDL concentrations did not significantly differ among all energy except plasma HDL. Then, ME2 had higher ($P<0.05$) HDL than ME1 energy diets. Based on results of the present study, it could be concluded that supplement of combination between industrial by-product of energy sources as PF and CSL could improve semen quality of billy goats concomitant goodness fertility, progressive kids sexual puberty, amending semen characteristics at puberty, reducing ration consumption, safely to feedlot performance and keeping blood metabolites in normal status.

Keywords: *welfare of male goats, puberty development, feedlot performance, non-conventional energy*.

INTRODUCTION

The welfare of male goats through to amendment fertility performance, breeding as sires, meat production has emerged as an increasing activity. The right welfare of male goat has a big impact on the production and reproduction of livestock, because it has become the most frequent limit to prepare male goats during fertility season, puberty and feedlot. In this context, the sexual puberty age characterized by the beginning of the reproductive activity and it has great importance for the breeding system. It allows defining management practices such as lots separation defined by sex, time of castration, early selection of animals for procreation and permitting greater effectiveness in the improvement of the herd (Pacheco *et al.,* 2009). Under improved feeding conditions males could speculated to reflect some potentiality as meat producers, sexual development and amelioration fertility. Energy is needed for maintenance of body functions such as muscle activity, chemistry work in the circulation of substance in the cell as synthesis-catalyst in the body, such as enzyme and hormones (Bushara and Abu Nikhaila, 2012). The highest cost of diet especially energy let to farmers resort to use the industrial by-products of factory residues such as protected fat (PF) and corn step liquor (CSL) to raise the nutritional value of the diet and provide energy sources with reasonable cost. In this respect, De Sousa *et al.* (2012) reported that lambs fed a higher energy required less time in the feedlot to reach the slaughtering weight when compared with lambs that received the less energy. Moreover, Shivambu *et al.* (2012) suggested that higher energy diet had the better feed conversion ratio. In addition, Adibmoradi *et al.* (2012) obtained that high energy in diets can compensate for an earlier period of a low nutritional plane through increasing feed intake and (or) enhancing efficiency of feed utilization. Furthermore, Hassan *et al.* (2011) found that supplying the right amount of energy has an important impact to the production and reproduction of livestock. There is also evidence that energy plays a major role in the reproductive processes, it could improve puberty and testicular evolution of male farm animals (Mellado *et al.,* 2012). Generally, Khalifa *et al.* (2013) concluded that basal diet complementary with non-conventional energy sources as admixture between 2.5% PF and 2.5% CSL was able to boost productive and reproductive performance of dairy Zaraibi nanny goats.

Therefore, the present research was planned with four experiments in order to reveal the impact of supplementing basal rations with admixture industrial by-product energy on fertility performance of billy goats, upbringing weaning male kids as sires for herd or growth to marketing and kids' blood metabolites.

MATERIALS AND METHODS

This investigation was conducted in El-Serw Experimental Research Station belongs to Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture, Egypt. The experimental study formed at April 2012 to July 2013.

The composition of energy diets

The chemical composition of the basal rations and ingredients using as energy sources are presented in Tables (1 and 2), respectively. The control basal metabolic energy (ME1) included 60% concentrates

Table (1): Chemical composition of CFM and RS (% as DM).

Item	Chemical composition %					
	OM	CP	EE	CF	NFE	Ash
CFM	89.25	14.42	3.45	12.16	59.22	10.75
RS	80.23	3.08	1.49	36.88	38.78	19.77

Table (2): Chemical composition of the experimental rations (% as DM).

Chemical analysis	Experimental energy rations	
	ME1	ME2
OM	87.14	90.58
CP	14.54	14.58
CF	15.57	12.77
EE	2.86	4.27
NFE	54.17	58.96
Ash	12.84	9.42
*ME (k cal/ kg DM)	3213	3230

**ME= metabolic energy (k cal/ kg DM), it determined by the formula according to Canbolat and Karabulut (2010).*

feed mixture (CFM) and 40% rice straws (RS) to generate gross energy 3213.67 k cal / kg DM. While, trial metabolic energy (ME2) at 3230.22 k cal /kg DM from 50% CFM+ 45% RS + 5% non –

conventional energy (2.5% PF + 2.5% CSL) according to DM/ kg. At submitting daily ration, the non-conventional energy sources alternated immediately into basal control diet. Fresh water and mineral licking salt blocks were available *ad libitum* throughout the experimental period. The chemical analysis of ME1 and ME2 were determined using standard procedures of AOAC (2007).

1. Fertility performance of billy goats

The fertility rate calculated as reproductive performance of two mature billy goats aged 32 months and weighed 51-52 kg. The two billy goats nourished either ME1 or ME2 for 60 days pre- breeding season and continue until post-breeding season. Forty-two similar mature nanny goats divided into two groups (n= 21 does / energy billy goat) used for assaying the fertility measurements. The fertility parameter measured were conception rate (number of does gravid / number of mated does), fecundity (total number of kids born / mated does) and prolificacy (total number of live kids born / does kidded).

Birth types; as single birth rate (number of kidding single/ total number of does kidded), twins birth rate (number of does kidding twins/ total number of does kidded), triplet birth rate (number of does kidded triplet / total number of does kidded), quaternary birth rate (number of does kidded quaternary / total number of does kidded) and litter size (number of total born kids /number of does kidded) were recorded.

2. Upbringing weaning male kids as sires

Eight weaning kids at 135 days of age and 15.85 kg average body weight were used. The kids were kept in separated pens in an open shaded barn under the same environmental condition and the ceiling of barn covered with asbestos. The kids were allocated into two groups (4 kids/energy level) and received ME1 or ME2 treatments. The kids were allowed 7 days adaptation on different energy levels. All energy levels adjusted every fifteen days according to NRC (2007) allowances for kids. The following parameters were assayed:

2.1. Sexual puberty phases

Sexual puberty phases observed for all kids within 25 minutes using an oestrus cycle nanny goat. The three pubertal phases as follows: first pubertal phase; kids showed mounting with desire trembling without penis exposure. Second pubertal phase; kids could display mounting with penis exposure. Third pubertal phase; kids produced first semen ejaculate containing motile sperm. The kids' age, scrotal circumference, testes' volume and testosterone levels were determined at each phase of puberty. The scrotal circumference (SC) obtained using a cloth tape and measured in centimeters (cm) as the largest diameter of scrotum after pushing the testes firmly into the scrotum. The testes volume (cm^3) = $0.015409 \times SC^3$ was determined according to Entwistle (1992). The testosterone level (ng/ml) was determined by kit produced by Germany IBL Company; with catalogs No RE52151 and the ELISA Plate Reader (Biotek ELX808, USA made).

2.2. Semen evaluation at puberty age

An artificial vagina and an oestrus cycle nanny goat were used to collect semen immediately after kids reached pubertal age. Semen characteristics such as volume, progressive motility, live sperm, normal sperm and sperm cell concentration were evaluated by method described by Roca *et al.* (1992).

2.3. Correlation Coefficients

Correlation coefficients were assayed among feeding, semen volume (SV), sperm cell concentration (SCC), testes volume (TV) and testosterone concentration (TC) when kids reached 3rd phase of puberty.

3. Kids growth performance to marketing

It was carried out with the previous eight kids that received the various two energy levels (allocated into 4 kids/ energy levels) the following parameters were measured:

3.1. Live body weight

Live body weight was recorded regular and at fortnightly interval before the morning feeding.

3.2. Feed intake and daily weight gain

In the day of evaluation, feed intake from either ME1 or ME2 rations was estimated every fortnightly as interval period. Feed intake was calculated by weighing the refusal diet, which collected every next morning at 07:00 am.

3.3. Feed conversion ratio

The feed conversion ratio was calculated as feed intake divided by the average body weight gain during the feedlot period.

3.4. Daily water intake

Water intake was measured monthly. Determination of the water consumption began at 07:00 am when 7.5 Litters of water burdened in plastic containers accommodated 10 Litters. After 24 hours, remained water was measured per ml to estimate daily water intake. This process repeated for an additional 24 hours. The water consumption was calculated as daily water intake (ml) ÷ total dry matter intake (TDMI, kg).

3.5. Economic efficiency

It was calculated as out-put (price of weight gain) ÷ input (total price of feed consumed) ×100.

4. Kids' blood metabolites

At the end of kid trials, blood samples were collected in the morning before feeding from the jugular vein in sterile syringe from 6 kids (3 of each energy level). The collected blood poured into clean test tubes containing heparinzied. Then, plasma harvested by centrifuging at 3000 *g* for 15 minutes and stored at -20°C until analysis. Plasma analyzed for concentrations of glucose, triglyceride, cholesterol, low-density lipoprotein cholesterol (LDL) and high density lipoprotein cholesterol (HDL) using enzymatic methods and appropriate kits (Pars-Azmon Co.) and Clima Plus Analyzer (RAL, Madrid, Spain).

Statistical analysis

The data in the present study was subjected to statistical analysis using General Linear Models Procedures (GLMP) adapted by SPSS for windows (Statistical package for social sciences version 22 Inc, Chicago, 2013) for user's guide. Duncan test of SPSS programme was done to determine the degree of significance between the means at P<0.05. Correlation between mean of feeding, semen volume, sperm concentration, testes volume and testosterone level were calculated using the Pearson's coefficients of SPSS.

RESULTS AND DISCUSSION

1. Fertility performance of billy goats

The effect of dietary energy was supplemented, as ME1 or ME2, on the fertility rate of mature billy goats shown in Table 3. There was increase in fertility rate calculated with billy goats fed ME2 compared to billy goat nourished . This observation was a response to energy material, which played an essential role in activating sperm movement in female genital tract. Supplementing energy sources can be provided ration by essential polyunsaturated fatty acids (PUFA) such as linoleic, linolenic, docosahexanoic (DHA), eicosapentaenoic acid (EPA) and docosapentaenoic acid (DPA) which associating on reproductive response (Yeste *et al.,* 2011). On this base, when rumen had PF in the diet it incorporates 8.5% ω-6 and 25-34 g/day linoleic acid appearing in small intestine which is not only an energy source, but also generates non-energetic benefits related to the impact of these fats on metabolism and hormonal and immune responses (Sanz Sampelayo et al., 2002). Earlier studies had shown that high PUFA in diets conjunction to increase sperm concentration, higher percentage of morphologically normal spermatozoa which associate with greater sperm fertility (Arns *et al.,* 2005). As outlined below, there is considerable evidence that dietary PUFA supplement could influence biosynthetic pathways involved in both prostaglandin synthesis and steroidogenesis that have multiple roles in the regulation of reproductive function (Claire Wathes *et al.,* 2007). According to Dolatpanah *et al.* (2008) energy has positive effect on the sperm number, semen volume and modifies the membrane structures, fluidity, and/or susceptibility to peroxidative damage. In addition, those authors reported that these modifications might affect the viability of spermatozoa in the female reproductive tract and/or their fusion capacity, inducing modifications of fertility rates. They reported that diets supplemented with energy as PUFA increased sperm motility, content of normal acrosome, sperm cell morphology so that the sperm deformity rate tended to decrease (Al-Daraji *et al.,* 2010). In addition, it was clear that diets containing different lipid sources change the lipid contents of sperm and mainly affect the sperm head and sperm body membranes (Safarinejad *et al.,* 2010). Similarly, Am-in *et al.* (2011) pointed out that total energy intake and appropriate ratio of PUFA in males were still positively associated with sperm concentration and sperm morphology. Furthermore, Yan *et al.* (2013) concluded that intake of energy in the diet increased sperm characteristics and enhanced the structure integrity of testis and sperm, thereby improving reproductive performance and hormone metabolism. Indeed, it known that fatty acid composition of sperm membranes, especially their unsaturated components, determine their biophysical characteristics, such as fluidity and flexibility, as appropriate for their specific functions including sperm motility and fertilizing capacity (Nada, 2013). Moreover, Fair *et al.* (2014) revealed that dietary-supplementation of rams with energy successfully increased the PUFA content of seminal plasma and sperm. On the other hand, Jafaroghli *et al.* (2014) showed that dietary supplement with energy substances improved semen quality, semen volume, percentages of progressive motile sperm, proportion of sperm with normal acrosome and may have beneficial effects on fertility in rams. Furthermore, Alizadeh *et al.* (2014) stated that sperm parameters improved dramatically with dietary energy and the ruminant spermatozoa membranes characteristically contain very high proportions of long-chain PUFA.

Table (3): Fertility rate of billy goats nourished different energy rations.

Parameter	Energy diets	
	ME1	ME2
No. of nanny goats mated	21	21
No. of nanny goat gravid	18	20
Conception rate, %	85.71	95.24
No. of nanny goat kidding	18	20
Total No. of kids born	38	44
No. of a live kids at birth	27	36
Fecundity,%	180.95	209.52
Prolificacy,%	150.00	180.00
Birth type of nanny goats		
No. of nanny goat born single	-	2
Single rate, %	-	10.00
No. of nanny goat born twins	16	13
Twins rate, %	88.89	65.00
No. of nanny goat born triple	2	4
Twins rate, %	11.11	20.00
No. of nanny goat born quaternary	-	1
Quaternary rate, %	-	5.00
Litter size, %	2.11	2.22

2. Upbringing weaning male kids as sires

2.1. Sexual puberty phases

Measurements of sexual puberty development such as puberty age, scrotal circumference, testes volume and testosterone levels of kids fed different energy diets post-weaning are presented in Table 4. In the first phase of pubertal development, the kids-nourished ME2 finished this stage of puberty earlier than those received ME1. The puberty ages during this stage were 189.00 and 150.00 days with either ME1 or ME2, respectively. Furthermore, the parameters of testes volume and testosterone level had increased values (P<0.05) in kids fed ME2 (95.49 cm^3, 0.94 ng/ml) than those kids nourished ME1 (39.79 cm^3, 0.44 ng/ml), respectively. These findings are consistent with Salam (2009) who noticed that high-energy ration increased the activity of the endocrine gland, particularly the pituitary gland. It is known that there are direct relationships between plane of nutrition and gonadotropin secretion in male ruminants. These results are in accord once with Mohamed and Abdelatif (2010) who suggested that males received the best plane of nutrition, chiefly energy, results in increased sexual hormones. In the second stage of sexual puberty development, the kids fed ME2 displayed younger (P<0.05) age to penis exposure (175.00 days) than those kids fed ME1 diets (213.00 days). In addition, in this phase, buckling testes volume and testosterone level had increased in ME2 ration (P<0.05) compared to ME1 ration. The testes volume reached 77.78 and 153.15 cm^3 while, testosterone level was 0.62 and 1.38 ng/ml for ME1 and ME2 kids, respectively. In this context, Adam *et al.* (2010) stated that results of pubertal characteristics of male kids reached earlier growth and directly correlated with scrotal circumference. The full sequence of puberty behavior of kids in the third stage was significantly higher for ME2 rations (P<0.05) than those kids supplied with ME1 rations. In this phase of puberty, the kids had suitable scrotal circumference, which is an indicative for testicular size and testosterone levels (Almeida *et al.,* 2007). Furthermore, Bezerra *et al.* (2009) revealed that puberty could happen between 4 and 17 months of age in young Boer goat male kids. Thus, the quality of rations presented to kids after weaning could change age of induced puberty. These observations explained with the study of Zarazaga *et al.* (2009) who recommended that puberty in kids and onset of sexual activity were influenced by energy quality and quantity. Therefore, the earliest pubertal stages in kids fed ME2 might relate to the highest metabolic energy of consumption rations. These results defined also by Blache *et al.* (2008) who reported that reproductive functions such as puberty and sexual maturity require high quantity of energy. On the other hands, Okere *et al.*, (2011) revealed that, scrotal circumference of young Boer goat male directly correlated to testosterone concentration. Furthermore, Machado *et al.* (2011) concluded that goats with superior scrotal bipartition have a great capacity to produce reproductive cells that reflected in reproductive potential. Likewise, Nasir *et al.* (2013) found that growth rate and age at complete separation of prepuce from the penis and scrotal circumference at puberty should be capable to express normal sexual behaviors that enable successful completion of puberty. In addition, these authors suggested that the age of crossbred male kids of Nubian × Saanen was reached puberty age between 29 and 31 weeks. According to Bompadre *et al.* (2014) lower energy for kids could attribute to the lower internal organ mass and lower protein turnover in kids in early life.

Table (4): Sexual puberty phases of male kids nourished different energy rations.

Sexual puberty phases	Different energy rations	
	ME1	ME2
First phase: mating with desire trembling without penis exposure		
Age, days	189.00±1.08[a]	150.00±3.07[b]
Scrotal circumference, Cm	13.68±0.45[b]	18.33±0.51[a]
Testicular volume, Cm^3	39.79±3.83[b]	95.49±8.25[a]
Testosterone concentration, ng/ml	0.44±0.01[b]	0.94±0.03[a]
Second phase: mating with penis exposure		
Age, days	213.00±1.07[a]	175.00±1.47[b]
Scrotal circumference, Cm	17.12±0.41[b]	21.45±0.60[a]
Testicular volume, Cm^3	77.78±5.54[b]	153.15±12.55[a]
Testosterone concentration, ng/ml	0.62±0.03[b]	1.38±0.05[a]
Third phase: mating with first semen ejaculate containing motile sperm		
Age, days	245.55±1.71[a]	216.82±1.85[b]
Scrotal circumference, Cm	19.98±0.52 [b]	24.00±0.61[a]
Testicular volume, Cm^3	123.57±9.62[b]	214.27±16.67[a]
Testosterone concentration, ng/ml	1.35±0.12[b]	2.40±0.29[a]

a, b means within the same rows with different superscripts are significantly different at (P<0.05).

2.2. Semen evaluation at puberty

The present data could indicate that semen characteristics showed significant improvement ($P < 0.05$) in kids given ME2 compared to those fed ME1 (Table 5). At all events, the current study explained that kids supplied with ME2 achieved improvement of semen characteristics that may reflect a good nutrition strategy. Hence, Atta *et al.*, (2011) reported that strategy of energy feeding could ameliorate semen characteristics, which predict the breeding value of a sire when used in natural tupping or artificial insemination. The results of the current study indicated that energy intake is one of the most important factors influencing reproductive performance. Meanwhile, Tufarelli *el al.* (2011) suggested that supplementing dietary energy resulted in improved body weight gain, feed intake, sperm production and semen quality. Selvaraju *et al.* (2012) concluded that increasing dietary energy improves semen quality especially volume and concentration as important factors in semen evaluation and scrotal circumference as a direct indicator of sperm production. On the other hand, Castellano *et al.* (2010) indicated that there was a clear influence of dietary lipids on spermatozoa fatty acid profile, the fatty acid composition of sperm and male germ cells. Hence, low dietary energy causes poor polyunsaturated fatty acids (PUFA); which makes it susceptible to oxidative damage because of the low concentration of PUFA present in the spermatozoa plasma membrane. This result confirms those of Yan *et al.* (2013) who suggested that sperm cells containing very high proportions of PUFA to maintain an adequate reactive oxygen species (ROS) in semen.

Table (5): Semen characteristics of male kids nourished different energy rations.

Semen characteristics	Different energy rations	
	ME1	ME2
Semen volume, ml	0.27±0.48 [b]	0.55±0.29 [a]
Progressive motility, %	23.75±2.24 [b]	41.25±2.39 [a]
Live sperm, %	28.75±1.93 [b]	50.00±2.61 [a]
Normal sperm, %	48.00±1.68 [b]	71.25±2.02 [a]
sperm concentration, n×10^9/ml	0.26±0.14[b]	0.62±0.19[a]

a, b means within the same rows with different superscripts are significantly different at (P<0.05).

2.3. Correlation Coefficients

Correlation coefficients are presented in Table 6. The content of feeding is positively correlated (P<0.01) with the SV, SCC, TV and TL of the examined kids. Hence, the SV and TV are suitable traits as selection criterion to improve reproductive performance. They are also traits that can easily measure in live animals. In this context, Gherardi *et al.* (1980) stated the highest correlation between testes volume and sperm cells production, and then these authors reported that each gram of testis produces about $20x10^6$ sperm cells daily, irrespective of size. Generally, several reports have documented the interrelationship between energy intake and sexual activity (Robinson *et al.*, 2006, Adam *et al.*, 2010, Okere *et al.*, 2011and Selvaraju *et al.*, 2012).

Table (6): Correlation coefficients among feeding and pubertal status.

Item	Feeding	SV	SCC	TV	TC
Feeding	1	0.902	0864	0.940	0.935
SV			0.997*	0.995*	0.997*
SCC				0.984*	0.986
TV					1.000**

SV= semen volume, SCC= sperm cell concentration, TV= testes volume and TC= testosterone concentration
**Correlation is significant at the (P<0.05).*
***Correlation is significant at the (P<0.01).*

3. Kids' growth performance to marketing

3.1. Live body weight

Data tabulated in Table 7 investigated changes in live body weight (LBW/kg) of kids provided with ME1 and ME2 from day 135 up to finishing study at day 255. During the first few weeks of feeding, the LBW of kids subjected to ME1 diet nearly similar to LBW of kids subjected to the ME2 diet. With advancing of feeding days, after day 195, the kids receiving ME2 started to gain weight faster than the kids received ME1 diet (P < 0.05). This result is in accordance with those of Silva *et al.* (2007) who found that covering energy requirement of animals is very important and it is chiefly derived from energy ingested and secondly from the mobilization and catabolism of body reserves. Moreover, it demonstrated that LBW of kids received ME2 diets tended to be slightly high compared to those kids fed ME1 at all trial times. Then, ME1 and ME2 finished feedlot at 23.70 and 26.70 kg LBW, respectively. The lowest LBW with ME1 energy might attribute to the greater concentration of fibrous carbohydrates in diets of low energy, which are less digestible. This is supported with the conclusions of Araújo *et al.* (2009) who reported that the increase in dietary energy value improved non-fibrous carbohydrate apparent digestibility which improve body growth. The variation in LBW of kids might relate to levels of energy intake. This observation is consistent with Hosseini *et al.* (2008) who found that energy is the major dietary element responsible for utilization of nutrients and thereby the productivity and body gain of an animal. In addition, energy promoters are the main factors affecting growth performance and body gain. This trend is in harmony with Canbolat and Karabulut (2010) who showed that average body growth, daily weight gain and feed efficiency increased with increasing level of energy in diets. Generally, increasing the energy level may allow the production of more fermentable metabolic energy (ME) for rumen microorganisms which result in a rise in synthesis of microbial protein, therefore the amount of protein available to the animal let to refinement body weight (Bhatt *et al.*, 2013). According to, Bompadre *et al.* (2014) energy requirements for maintenance and gain in intact males, adequate supply of energy is essential to maintain normal body function like growth and major environmental factor affecting reproductive performance.

Table (7): Live body weight of male kids nourished different energy levels.

Energy level	Weighing days post-weaning								
	135	150	165	180	195	210	225	240	255
ME1	15.85 ±0.32	16.03 ±0.29	16.80 ±0.42	17.96 ±0.39	19.20 ^{b} ±0.45	19.80 ^{b} ±0.45	21.40 ^{b} ±0.49	22.35 ^{b} ±0.66	23.70^{b} ±0.64
ME2	15.85 ±0.61	17.40 ±0.57	18.50 ±0.59	19.85 ±0.61	21.75 ^{a} ±0.46	22.60 ^{a} ±0.85	24.30 ^{a} ±0.72	25.55^{a} ±0.49	26.70^{a} ±0.48

a, b means within the same columns with different superscripts are significantly different at (P<0.05).

Data illustrated in Table (8) identify the significant (P<0.05) differences among energy groups in total dry matter intake (TDMI), average daily weight gain (ADWG), feed conversion ratio (FCR) and daily water intake. Furthermore, the metabolic mid-weight (MMW) which achieved by applying component of appropriate weights index (feed intake and body weight gain). Hence, the Kids of ME1 and ME2 had realized MMW at weights 12.07 and 12.56 kg, respectively. In addition, the present study shows lower feed cost and better economic efficiency in kids of ME2 than those of ME1. Consequently, the results in Table (8) were discussed as following:

3.2. Feed intake and daily weight gain

In connection with voluntary feed intake, the kids fed ME1 consumed more total diet than those fed ME2. Increasing dietary energy resulted in decreasing voluntary feed intake. This result is in agreement with the findings of Atay *et al.* (2011) who reported that the highest voluntary feed intake found in goats fed with diet without direct energy sources. Moreover, Park *et al.* (2013) mentioned that the amounts of feed intake were affected by adding fat to diets of ruminants and depends not only on the type of fat but also on the amount added.

Concerning ADWG, similar trend was reported by El-Gallad *et al.* (1988) who found that feeding high energy diets resulted in relatively better ADWG (55 to 61 g/day) than Zaraibi kids fed low energy rations. The higher ADWG recorded with kids fed ME2 than those fed ME1 correspond with those reported by Hossain *et al.* (2003) and Johnson *et al.* (2010) they indicated that average daily gain was surpassed in goat kids fed higher energy diet than kids fed lower energy diet. Otherwise, increasing of ADWG may be related to changing in dietary amount of energy intake; it accomplished 65.42 & 90.42 g/ h / day for ME1 and ME2, respectively. This trend coincided with the findings of Hassan *et al.* (2011) who concluded that average daily weights gain were 60, 70 and 80 g/day when kids treated with different energy levels such as sunflower cake at level at 0, 15 and 25%, respectively. In general, the diet with the highest concentration of energy has the best proportion of volatile fatty acids, mainly ruminal propionate, after being absorbed by the rumen wall. This result is explained with Sousa *et al.* (2012) who stated that these fatty acids become the main substrate of hepatic gluconeogenesis, resulting in a greater availability of energy and consequently greater daily average weight gain. Hence, these authors evaluated the performance of lambs subjected to two feeding energy systems, level 2.90 Mcal/kg DM that have a greater average daily gain 258.15 g/d compared with 204.15 g/d, when lambs received 2.40 Mcal/kg DM, respectively.

3.3. Feed conversion ratio (FCR)

The values of FCR in this study were 17.83 and 12.23 DMI/kg gain for kids fed ME1, and ME2, respectively. This finding is poorer than that reported by Shahjalal *et al.* (1992) that feed conversion ratios was 7.19 and 10.1 for high and low energy fed to Angora goats. Mahgoub *et al.* (2000) found that FCR in lambs improved as the dietary energy level change. The FCR considered important parameter in meat production, it determines the unit of feed consumed for unit of weight gain and energy had a positive effect on the FCR (Yagoub and Talha 2009). On the other hand, Sousa *et al.* (2012) concluded that lambs fed 2.90 Mcal/kg DM-diet had a higher FCR (16.54) compared with the lambs subjected to the diet containing 2.40 Mcal/kg DM (FCE, 15.84). Moreover, Rahman *et al.* (2013) showed that supplementation of energy had a positive effect on daily body weight gain and feed conversion ratio.

Table (8): Feedlot performance of male kids nourished different energy rations.

Item	Different energy rations	
	ME1	ME2
No. of feedlot kids	4	4
Duration of feedlot (days)	120	120
Initial body weight (kg)	15.85±0.32	15.85±0.57
Final body weight (kg)	23.70±0.43	26.70±0.48
Total body gain (kg)	7.85±0.70	10.85±0.34
Average daily weigh gain (ADWG), g /h	65.42±3.12^{b}	90.42±1.52^{a}
*Metabolic mid-weight (MMW), kg	12.07	12.56
	Feed intake	
Concentrate (g/day)	643.63±8.86^{a}	592.00±9.51^{b}
Roughage (g/day)	522.88±2.81^{a}	461.75±8.91^{b}
Energy of PF (g/day)	-	26.00
Energy of CSL (g/day)	-	26.00
Total food intake (TFI), g/day	1166.51±9.44^{a}	1105.75±13.83^{b}
C : R ratio	55: 45	56: 44
Feed conversion ratio (FCR) TFI / ADWG	17.83±0.64^{a}	12.23±0.17^{b}
	Water consumption	
Daily water drink ml/day	3150.0±40.00^{a}	2321.80±17.35^{b}
Water consumption	2.7±0.12^{a}	2.2±0.06^{b}
	Calculation of economical efficiency	
Price of CFM /h/ d, pounds	1.93	1.78
Price of RS /h/d, pounds	0.13	0.12
Price of PF /h/d, pound	-	0.16
Price of CSL/h/d, pound	-	0.02
Total price of feed cost consumed (TPFC) ^{A}	2.06	2.08
Feed cost TPFC÷ADWG(kg)	31.69	23.11
Price of kg LBW × ADWG(kg)^{B}	2.28	3.15
**Economical efficiency(EE) B ÷ A, %	110.68	151.44
**EE% relative,%	100.00	136.83

a, b means within the same rows with different superscripts are significantly different (P < 0.05).
Price of kg LBW is 35 (EGP).
Price of CFM, RS bales, PF and CSL =3000, 250, 6000, 600 EGP /ton, respectively.
** Metabolic mid-weight (MMW) was calculated as: (Initial body weight (kg) + Final body weight (kg) ÷ 2) $^{0.75}$ according to Willems et al. (2013).*
***Economic efficiency (%) = money out put (price of buy meat) ÷ money input (total price of feed consumed) ×100.*
**** EE (%) relative to control with ME2= EE of ME2 – EE of ME1÷ EE of ME1×100 +100 (conceder EE of ME1 100%).*

3.4. Daily water intake

Regarding daily water intake, the diet with the lowest energy resulted (P<0.05) greater in amount of water intake. Similarly, Sheridan *et al.* (2000) recorded that daily water intake /head was 2.44 L and 1.97 L and the efficiency of water intake was 1.82 L/kg DM and 1.71 L/kg DM for low- and high-energy diets, respectively. These authors found also that diets contained a high ratio of concentrate do not promote greater rumination and require greater water intake. However, when water consumption calculated, kids fed ME1 or ME2 consumed 2.70 and 2.20 ml/kg diets, respectively. This result get along with Barreto *et al.* (2012) who emphasized that goats fed diet of high energy displayed significant decrease in consumption of water and dry matter when compared to those fed a diet of low energy.

3.5. Economical efficiency

The lowest feed cost was recorded by ME2, which had better (lowest) feed conversion and the highest daily body weight gain than ME1. This finding indicated that energy level in ME2 is more profitable than those kids in ME1. Thus, the calculation of economical efficiency of kid in ME2 gave the highest economical efficiency value compared to kids in ME1. Similar result reported by Abd El-Rahman *et al.*

(2012) that energy supplementation to diet decreased the feed intake required for 1 kg daily weight gain but amended the feed efficiency. On the other hand, Ríos-Rincón *et al.* (2014) concluded that dietary metabolic energy >2.80 Mcal/kg play a more important role in feed efficiency and that energy levels did not influence the final weight and average daily gain, but resulted in lower DMI values and higher gain efficiencies. In addition, these authors explained that providing a level of protein above 14.5% did not improve growth-performance, dietary energetics or carcass dressing percentage.

4. Kids' blood metabolites

Data presented in Table (9) cleared non-significant (P>0.05) differences in blood plasma metabolites glucose, triglycerides, total cholesterol and LDL among energy treatments tested. In general, this result is generally in agreement with Adibmoradi *et al.* (2012) who defined that blood plasma glucose, triglycerides, total cholesterol, HDL and LDL did not significantly differ among kids fed rations containing different levels of energy. Finding of, Agazzi *et al.* (2010) revealed that different fatty acids supplementation to goat' rations did not affect blood plasma parameters. On the contrary, plasma HDL concentration was attained significantly (P<0.05) higher level with ME2 (72.82 ng/ml) than ME1 (70.04 ng/ml). The slightly higher (P>0.05) of cholesterol in ME2 may be related to better values of HDL than kids in ME1. These findings in agreement with Mellado *et al.* (2012) who noticed that serum concentrations of cholesterol was higher in group fed ration contained high energy than those fed low energy that might attempt to changing ratio between LDL and HDL ratio. Also, Hayat *et al.* (2012) concluded that calcium soap of fatty acids supplement to diets produced significant changes in blood lipid composition and modified the metabolism of fatty acids.

Table (9): Blood metabolites of male kids nourished different energy rations.

Blood metabolites	Different energy rations	
	ME1	ME2
Glucose, mg/ dl	75.51±0.35	75.15±1.04
Triglyceride, mg/ dl	7.59±0.32	8.19±0.23
Cholesterol, mg/ dl	111.31±0.91	111.51±0.79
LDL, mg/ dl	43.34±0.45	42.20±0.41
HDL, mg/dl	70.04±0.60 [b]	72.82±0.61 [a]

a, b means within the same rows with different superscripts are significantly different (P < 0.05).

CONCLUSION

It is evident from the present study that mixed energy between 2.5% PF and 2.5% CSL indicated early positive effect on semen quality and consequently better fertility rate of mature goats, sexual puberty age, testes development, body weight and average daily gain of kids. Moreover, supplemented energy decreased the cumulative feed intake, water consumption and improved feed conversion ratio of kids. Furthermore, the current results show that the tested non-conventional energy diet reflected acceptable blood parameters of kids.

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تغذية الطاقة التقليدية وغير التقليدية وأثرهما على الأداء الإنتاجى والتناسلى لذكور الماعز الزرايبى

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1مركز البحوث الزراعية- معهد بحوث الإنتاج الحيواني قسم بحوث الأغنام والماعز- الدقى- الجيزة – مصر

2مركز البحوث الزراعية- معهد بحوث الإنتاج الحيواني قسم بحوث المخلفات- الدقى- الجيزة – مصر

تمت أربع تجارب لتقييم تأثير خلط مخلفات التصنيع (الطاقة الغير تقليدية) مثل الخلط بين الدهن المحمى ومياه منقوع الذرة على الأداء الإنتاجى والتناسلى لذكور الماعز. وجهزت التجربة مستويين من الطاقة ط1 (مقارنة) لتعطى طاقة كلية 300.21 و ط2 (معاملة) لتعطى طاقة كلية 332.64 كالورى / 100جم غذاء. وكانت مكونات العليقة(كنترول) ط601% مخلوط العلف المركز و40% قش الأرز بينما العليقة المعاملة ط2 إحتوت على 55% مخلوط العلف المركز و40% قش الأرز مكملة ب 2.5% دهن محمى +2.5% مياه منقوع الذرة. التجربة الأولى استخدمت 2 ذكور ماعز ناضجة عمرها 32 شهر ووزنها 51-52 كجم لتقييم الخصوبة وغذى ذكور المجموعة الأولى على ط1 والثانى على ط2 وقدمت الطاقة للذكور قبل 60 يوم من التلقيح واستمرت التغذية حتى نهاية موسم التلقيح. واستخدم 42 عنزة متماثلة وقسمت على النحو التالى 21 عنزة/مجموعة /ذكر. التجربة الثانية لدراسة تنشئة الجداء كطلائق أستخدم فى الدراسة 8 من جداء الماعز الزرايبى مفطومة متوسط وزنها في بداية التجربة15.85 كجم وعمر 135 يوم قد قسمت إلى مجموعتين متساوية فى العدد (4 جداء / مجموعة طاقة) وغذيت الجداء على ط1,ط 4. وتم حساب التقدم فى العمر اثناء البلوغ وقياس التغير في والوزن ومحيط كيس الصفن وحجم الخصية و تركيز هرمون التستيرون خلال مراحل البلوغ الجنسي و تم تقييم صفات السائل المنوي عند البلوغ. التجربة الثالثة لدراسة تسمين الجداء واستخدمت الجداء السابقة 8جداء (4جداء /مجموعة طاقة) على نفس مستويات الطاقة ط1،ط2 وتم تقدير الزيادة فى الوزن , معدلات النمو اليومية ,المأكول اليومي , كفاءة التحويل الغذائي , المستهلك من المياه , الكفاءة الغذائية ،الكفاءة الأقتصادية أثناء تسمين الجداء. التجربة الرابعة واجريت فى نهاية التجربة بإستخدام 6 جداء قسمت إلى (3جداء/ مجموعة طاقة) وتم أخذ عينات الدم وذلك لتقدير بعض القياسات البيوكيميائية مثل الجلوكوز - الجليسريدات الثلاثية - الكوليستيرول الكلي - وتركيز اللبيدات العالية الكثافة والمنخفضة الكثافة.. وأوضحت النتائج فى التجربة الأولى أن الذكر المغذى على ط2 حقق معدلات عالية من الحمل, عدد الجداء المولودة, وحجم البطن مقارنة بالذكر المغذى على ط1. والنتائج فى التجربة الثانية اوضحت أن جداء ط2 كانت أفضل خلال مراحل البلوغ الجنسى وحققت زيادة معنوية (0.05%) لقياسات حجم الخصية ومستوى هرمون التستيرون وكذلك صفات السائل المنوي مقارنة بالجداء المغذاه على مصادر الطاقة ط1. وقد أظهرت التجربة الثالثة أن عليقة ط 2 أفضل زيادة معنوية عند مستوى(0.05%) في معدل النمو اليومي والكفاءة الغذائية بالمقارنة بجداء ط1 .وكذلك إنخفضت كمية المأكول من المادة الجافة ,معدل التحويل الغذائي ,المستهلك من مياه الشرب و التكلفة الغذائية والكفائة الأقتصادية لجداء ط2 مقارنة بجداء ط1. وبالنسبة للتجربة الرابعة اوضحت أن مستوى تركيز سكر الجلوكوز، الجليسريدات الثلاثية , الكوليستيرول الكلى والمنخفضة الكثافة لم تتأثر معنويا بين العلائق المختبرة. ومن هنا توصى هذة الدراسة أن إضافة الخيلط لمخلفات الطاقة مثل الدهن المحمى ومنقوع الذرة تحقق التقدم فى معدلات الخصوبة للذكور الناضجة ، عمر البلوغ الجنسى و الحصول على أفضل صفات للسائل المنوي بعد البلوغ ,الإقلال من استهلاك العليقة و المحافظة على أيض الدم فى الحالة الطبيعية و أداء آمن للتسمين.