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Effects of commercial fatty acids, organic acids and mineral supplementation on milk yield and blood characteristics of dairy goats in selected farms in Kelantan, Malaysia

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Abstract

Milk production of dairy goats raised by smallholders in Malaysia are usually very low with which are mainly attributed to poor nutrition. This study was aimed at evaluating the benefits of supplementing commercial fatty acids, organic acids and chelated minerals for enhancing milk production. Eighty Saanen dairy goats in the stage of mid-lactation were selected from 8 smallholder farms in Kelantan, Malaysia to evaluate their blood profile and mineral status in relation to their daily rations. Based on estimated dry matter intake (DMI), 50% of the animals were found not adequately fed, with deficit of 6% - 12% from the targeted DMI. Initial screening of the blood revealed that red blood cell (RBC), haemoglobin (HGB), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) values were marginally low while sodium (Na) was deficient. Based on these findings, 6 groups of 10 Saanen dairy goats from 6 farms were selected from the above 8 farms for the second trial. Five animals in each group were supplemented with either commercial fatty acids, organic acids and chelated minerals, while another 5 were not supplemented and fed only on routine rations. A formulated feed mixture, which comprised of PKC, NaCl, $CaCO_3$, zeolite and mineral-vitamin premix at the rate of 100, 15, 15, 5 and10 g/day respectively were provided to the supplemented groups on top of routine rations. Supplementation of fatty acids (Extima 100, Extima 300, Extima Star and Extima 100 + Extima Star at the rate of 100, 100, 100 and 50+50 g/day), chelated mineral (POWERMIN 4COW/CATTLE+P, 400g/day) and organic acid (ORGACID, 100 g/day) to the respective supplemented groups resulted in improvement in certain blood characteristics and enhanced Na level. The improvement in milk yield associated with supplementation was between 12 – 16%. However, body condition score (BCS) of the supplemented groups were improved as compared to those non-supplemented. The findings revealed that supplementation of the above supplements, even with limited amount of a formulated feed mixture were less effective in enhancing milk yield of the dairy goats raised under the smallholders feeding condition.

1. INTRODUCTION

Malaysian dairy industry is changing rapidly as growth, development, rural to urban migration, shifting diets, and more liberalized trade and investment policies enhance competition among milk processors and interest groups. Goats are important possessions to the developing world by providing nutritious substances to the local populace in general and as a means of livelihood, people often used products from dairy goats which plays a role in the diets of the human populace and its sustainability is necessitated (Haenleine, 2001). Large increases in per capita and total demand for meat, and milk are forecast for most developing countries for the next few decades in which Malaysia's is engaged (Delgado et al., 1999). The importance of using local feed resources as the key driving dynamics to increase the productivity of animals in Asia has been emphasized by Devendra and Leng (2011).

Milk yield of dairy goats raised by smallholders in Kelantan are usually very low with the range of 1 – 2 litre per day only. Apart from breed and heat stress, poor nutrition and feeding is one of the major limiting factors that can reduce their performance. It is a fact that until today, there is no specific nutrient requirement that is available for the use as a reference in raising milk goats under Malaysian tropical environment. The purpose of this study is to evaluate the benefits of supplementing commercial fatty acids, organic acids and chelated minerals in enhancing their milk yield and general health. The findings could be used to develop suitable total mix ration (TMR) for dairy goats in Malaysia.

2. MATERIALS AND METHODS

2.1. Farms and animals

A total of 80 heads of Saanen dairy goats, in the mid lactating stage, approximately 4 – 5 months after

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giving birth were selected from 8 small-scale dairy goat farms covering 4 districts in Kelantan, namely Pasir Mas, Machang, Kota Bharu and Tanah Merah. All animals received routine deworming program which were handled by the Departments of Veterinary Service (DVS), the state of Kelantan. The nutrient status of the animals in each group were obtained by interviewing the smallholder farmers concerned by using a standard questionnaire. The objective was to identify the type and amount of ingredients commonly used in the daily rations, daily feeding frequency and daily milk yield. The data gathered provided initial information on the animal background, daily feeding management as practised by each smallholder and their level of knowledge on goat nutrition.

Out of the 8 farms above, 6 farms each having 10 lactating dairy goats were selected for the following trial. The randomization of the animals in each group were based on live-weight. All of the animals were treated with anthelmintic (fendbendazole) before the commencement of the trial to overcome parasite infestation. Five (5) animals from each farm were used as the not-supplemented group whereas another 5 animals were used as the supplemented groups. The supplement provided to the respective group is shown in Table 1.

Table 1: Allocation of the experimental animals and type of supplementation between farms

C	Number of animals	Treatment
A	5	Not-supplemented[++]
	5	Feed mixture[@] + 100 g EXTIMA 100
B	5	Not-supplemented
	5	Additional feed mixture + 100 g EXTIMA 300
C	5	Not-supplemented
	5	Additional feed mixture + 100 g EXTIMA STAR
D	5	Not-supplemented
	5	Additional feed mixture + 400 g POWERMIN 4COW/CATTLE+P
E	5	Not-supplemented
	5	Additional feed mixture + 100 g ORGACID
F	5	Not-supplemented
	5	Additional feed mixture + 50 g EXTIMA 100 + 50 g EXTIMA STAR

Notes:++ All the not-supplemented groups were fed existing diet (Refer to Table 2)

[@]Additional Feed mixture: PKC, sodium chloride, calcium carbonate, zeolite and mineral-vitamin premix at the rate of 100, 15, 15, 5 and10 g/day respectively. ORGACIDSs and EXTIMA products: Manufactured by Erafeed Sdn Bhd., Lot 4089, Jalan P4/8K, Bandar Teknologi Kajang, Semenyih, Selangor, Malaysia. POWERMIN 4COW/CATTLE+P (Chelated Minerals): Manufactured by Ritamix Sdn. Bhd., No.7, Jalan TP7, UEP Industrial Park, 40400 Shah Alam, Selangor, Malaysia.

Each supplement was precisely weighed into a plastic bag by using an analytical balance. The mixtures were mixed uniformly before transporting to each farm. Daily dosages of each supplement were based on the recommendation from the company concerned. The animals were fed individually in their pens. The duration of the trial was four months.

2.2. Ration

The rations given to the dairy goats vary from farm to farm and were given twice per day i.e. grasses in the morning (about 9.00 am) and concentrate (mostly commercial goat pellets) in the afternoon (about 3.00 pm). There were two types of commercial pellets available, i.e. pellet A (produced by Soon Soon Sdn Bhd) and pellet B (produced by Cargill Sdn. Bhd). In some of the farms, soya hull, palm kernel expeller (PKE), soya bean meal, soya waste and wheat pollard were also used in combination with grasses and commercial pellets.

2.3. Body condition score (BCS)

The animals were observed with the necessary protocols for the BCS, and the scoring of 1-5 was based on the standards for goats. Scoring was done at the beginning of the experimentation by a professor from the Faculty of Veterinary Medicine, UMK.

2.4. Blood plasma collection and analysis

The plasma samples were collected via the jugular vein by using vacutainer tubes with heparin as anticoagulant. The blood collected was kept in ice packs and transported to the laboratory for analysis. The blood samples were centrifuged at 3000 rpm for 20 minutes to separate the red blood cells (RBC) from the other blood components. Mineral contents in plasma were analysed by atomic absorption spectroscopy (AAS) machine (Pinnacle 900 Series).

2.5. Chemical analysis

The feed samples were analysed for dry matter (DM), ash, crude protein (CP), crude fibre (CF), ether extract (EE) and gross energy (GE). Method of analysis was based on the standard AOAC method (2000). The DM was determined by oven drying in forced air oven for 24 h at 110oC. The ash content was determined by ashing the samples in carbolite furnace at 600oC for 6 hour. Determination of CP involved three different stages. The first stage involved digesting of the sample with concentrated acid, followed by distillation process with alkali by Kjeldahl system and finally titration against the acid. The amount of nitrogen (N) found were converted to CP (CP=N*6.25). Determination of CF was carried out after sample digestion with diluted acid, alkali and alcohol. Determination of EE was done by extraction in petroleum ether (60-80oC) by Soxhlet Extraction System. Nitrogen free extract (NFE) was calculated based on the equation: 100 - (DM+ash+CP+CF+EE). All samples were analysed in triplicate where the mean and standard error were calculated.

2.6. Statistical analysis

The data collected in this study were analysed by using one way ANOVA at 95% confidence interval ($p<0.05$). T-test was used in comparing the means of the two groups when the results were combined for the not-supplemented and supplemented groups respectively.

3. RESULTS AND DISCUSSION

3.1. Type of feeds, dry matter intake (DMI), blood profiling and plasma mineral concentration

The general background of Saanen dairy goats and type of feeds given between farms is shown in Table 2. Body weight of lactating females in each farm varied from 35 – 50 kg. Their body condition score (BCS) varied from 2.0 (farm B) to 4.0 (farms F) but majority were from 3.0 to 3.5. The two smallholders from farms F and G were found to have superior knowledge on goat nutrition and these are reflected in the doe's milk yield (capability of reaching 3.5 to 4.0 litres of milk/head/day).

Table 2: General Background of the Dairy Goats and Type of Feeds Given Between Farms.

Farm	Location (Village/ District)	No of Lactating goats	Body weight (kg)+	BCS	Grass: Others ratio	Type of Grass given	Type of concentrate / commercial feed given	Average milk yield (litre/day)@	KGN++
A	Kg. Tar Tujuh, Pasir Mas	10	35 – 40	3.0	80:20	Local grass (2 kg)	Pellet A (0.5kg)	1.5 – 2.0	2
B	Kg. Tar Tujuh, Pasir Mas	10	35 – 40	2.0	80:20	Local grass (2 kg)	Pellet B (0.5 kg)	1.0 – 1.5	3
C	Kg. Tar Tujuh, Pasir Mas	10	35 – 45	3.0	70:30	Napier grass (2.5kg)	Soya hull (0.5 kg) Pellet A (0.5 kg)	2.0 - 2.3	3
D	Kg. Tar Tujuh, Pasir Mas	10	35 – 50	3.0	70:30	Napier grass (2.5 kg)	Soya hull (0.5 kg) Pellet A (0.5 kg)	1.5 – 2.0	3
E	Kg. Tar Tujuh Pasir Mas	10	35 – 50	3.0	60:40	Setaria grass (1.5 kg)	PKE (0.5 kg) Soya bean meal (0.5 kg)	1.5 – 2.0	3
F	Ketereh	10	35 – 50	4.0	50:50	Napier grass (2.0 kg)	Soya waste (1.0 kg) Pellet B (0.50 kg) Wheat pollard (0.5 kg) Salt block	2.5 – 4.0	1
G	Pantai Cahaya Bulan, Kota Bharu	10	45 – 50	3.5	60:40	*Brachiaria humidicola (1.5 kg)*	Own mixture (1.5 kg)	2.0 – 3.5	1
H	Kemahang, Tanah Merah	10	35 – 45	3.5	50:50	Napier grass (1.0kg)	Soya hull (0.5 kg) Pellet A (0.5 kg)	2.0-2.5	1

Notes: BCS: Body condition score (using a standard BCS chart)
KGN++: Knowledge on goat nutrition (1: Excellent, 2: Average, 3: Poor)
@ Milkyields were measured by different in weight
* Calculated based on 4.0% of mean live-weight of lactating goats.

Table 3 shows the blood profiling of dairy goats from the eight farms studied. The blood profiling from farms G and H were not determined due to machine breakdown; however mineral analysis was carried out. It is evident that white blood cell (WBC) had increased slightly in farms B, D and F as compared to the other farms. The WBC are cell of the immune system which are involved in defence, protection, surveillance and nursing of infectious disease and foreign bodies. Increased leucocytes in the blood is often an indicator of disease while WBC are capable of generating antibodies in the process of phagocytosis and a high degree of resistance to disease when augmented (Soetan and Akinrinde, 2013; Isaac et al., 2013). The increase in the WBC in farms B, D and F could be due to infections, stress and anaemia which is related to management practice of the farms as had been reported earlier (Bagby, 2007). RBC is involved in the transport of oxygen (O) and CO2 in the body, and a drop in the RBC implies a decrease in level of O that would be carried into the tissue, as well as level of C02 that returned to the lungs.

The superiority of RBC and the amount depends on nutrients availability, state of health and physiological status of such animals (Soetan and Akinrinde, 2013). Animals with sound health, that are provided with good feeding, environmental conditions and other managements welfare would have a good amount of RBC which ranged

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from (4-6.2 x106/µl (Ekaette et al., 2013). RBC helps to diagnose anaemia and other conditions affecting blood cells (Bunn, 2011). Low RBC as observed in this trial may be due to anaemia, toxins in the feeds, and deficiency of certain micro-minerals (for example Fe and Cu) and vitamin (example vitamin B12 and B6). Some drugs also can decrease RBC (Bunn, 2011). Mean Hb and MCHC concentration of 8.41 g/dl and 21.0 g/dl were lower than the normal range of 11-17 g/dl and 30 –35 g/dl respectively, indicating that all animals were hypochromic in anaemia (Aster, 2004). Normocytic hypochromic anaemia is likely to exist if animals are deficient in Fe as have been observed in this trial. The respective Hct and MCV values of 41.4% and 18.7% were within the normal ranges of 35-55% and 18-25% respectively.

Table 3: Blood profiling of dairy goats between farms.

Farm	WBC (4-12)X10^3/µl	LYM(1-5)X10^3/µl	MON (0.1-1.0)X10^3/µl	GRA (2-8)X10^3/µl	RBC (4-6.20)x10^6/µl	Hgb (11-17)g/dl	Hct (35-55)%	MCV (18-25)fl	MCH (5-8)Pg	MCHC (30-35)g/dl	PLT (150-400)x10 3/µl	MPV (7-11)µm^3
A	12.64±5.30	4.20±3.80	0.49±0.26	8.0±2.59	3.56±0.54	8.03±0.97	41.53±5.70	18.84±0.86	3.70±0.39	19.54±1.99	450±178.4	4.20±0.11
B	9.59±3.15	3.00±1.80	0.41±0.09	6.21±2.79	3.59±0.44	7.40±0.622	40.53±5.33	18.48±0.29	3.41±0.26	18.34±1.53	520±263	4.20±0.122
C	8.4±2.51	1.73±0.29	0.29±0.10	5.7±1.53	3.6±0.32	7.21±0.37	41.5±4.40	18.6±0.85	3.25±0.23	18±1.73	392.4±184.3	4.04±0.12
D	12.27±3.89	3.27±2.48	0.52±0.24	8.49±2.66	3.94±0.54	9.71±0.923	45.8±7.76	19±1.39	4.1±0.67	21.29±4.80	462±311	4.23±0.30
E	11.83±2.04	1.83±0.76	0.5±0.08	9.47±1.25	3.44±0.72	7.73±1.04	39.3±8.26	18.67±0.45	3.8±0.67	20.37±3.95	458±74.4	4.27±0.39
F	13.8±5.40	6.21±4.27	0.54±0.22	7.54±2.33	3.30±0.70	10.4±2.79	40±7.20	18.57±0.93	5.13±1.14	27.29±5.13	421±262	5.7±1.77
G						Blood profiling not done						
H						Blood profiling not done						
Mean± SD	11.40±3.72	3.40±2.23	0.46±0.17	7.57±2.20	3.6±0.54	8.41±1.12	41.4±6.44	18.7±0.80	3.9±0.60	21.0±3.19	450.6±212.2	4.44±0.47

Notes: WBC: White blood cell, LYM: Lymphocytes, MON: Monocytes; GRA: Granulocytes; RBC: Red blood cell, Hgb: Haemoglobin, Hct: Haematocrit, MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin, MCHC: Mean corpuscular haemoglobin concentration, PLT; Platelets. Statistical analysis by one way Anova.

Plasma Ca, P, Mg, Na, K, Cu and Zn were within normal acceptable limits (Al-Khayat et al.,2012) with the overall mean of 9.05, 6.50, 2.8, 2536, 184.1, 0.74 and 0.63 mg/dl respectively (Table 4). There were no significance differences between farms when comparison was made for each element. Marginal Ca level was however found in animals in farm E with the mean of 7.63 mg/dl. These results suggested that the animals were not facing with mineral deficiencies and the daily diets consumed were possibly adequate and balanced in term of mineral contents. These results were also in agreement to the study on crossbred Boer goats raised by smallholders in Bachok and Pasir Puteh Districts, Kelantan (Al-Khayat et. al, 2012). Mineral adequacy was also observed in local crossbred goats raised in an institutional farm (Wan Zahari and Abdul Wahid, 1985).

Table 4: Plasma Mineral concentrations in dairy goats between farms (mg/dl) (mean and SD).

Farm	Ca	P	Mg	Na	K	Cu	Zn
A	8.25±0.52	5.71±0.71	2.64±0.17	2487±99	200±75.0	0.90±0.21	0.70±0.22
B	8.90±1.30	7.53±2.32	2.51±0.24	2623±658	198±70.9	0.75±0.25	0.66±0.25
C	8.17±1.61	7.37±1.10	2.39±0.22	2126±584	154±25.2	0.79±0.18	0.45±0.17
D	10.3±1.06	6.16±2.51	2.92±0.86	2608±288	177±17.2	0.60±0.34	0.56±0.41
E	7.63±0.29	5.67±0.48	3.12±0.84	2943±764	165±16.5	0.63±0.18	0.38±0.05
F	10.1±0.80	7.0±1.00	3.0±0.47	2484±511	204±75.4	0.73±0.37	0.67±0.30
G	9.5±0.95	5.70±0.80	3.08±0.18	2533±61	170±18.0	0.88±0.08	0.92±0.47
H	9.29±0.62	6.60±1.72	2.7±0.29	2485±661	205±90.0	0.66±0.26	0.69±0.38
Mean	9.05±0.90	6.50±1.33	2.8±0.41	2536±453	184.1±49.0	0.74±0.23	0.63±0.30

The respective mean Mg and K concentration of 2.8 mg/dl and 184.1mg/dl obtained in this study were however very much lower than the value of 26.4 mg/dl and 549.7 mg/dl as reported in the earlier study (Al-Khayat et. al., 2012). However the respective mean Na concentration of 2485 mg/dl was comparable to the values of 2308 mg/dl obtained in the earlier study (Al-Khayat et. al., 2012). These values gave a Na: K ratio of 13.4:1 in the former as compared to 4.93:1 in the latter. Large variations between the two trials could be attributed to species differences and their feeding regiments. The latter study was using crossbred Boer goats whereas the former study utilized Saanen dairy goats. The crossbred goats were fed with Napier grass (Pennisetum purpureum) and a concentrate mixture (consisted of PKE, soya bean waste, zeolite and rice bran) and were allowed free grazing for 4-6 hours. On the other hand, Saanen dairy goats were fed with a mixture of improved and local grasses plus concentrate. Mean plasma Cu and Zn of dairy goats were 0.66 and 0.69 mg/dl

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respectively and the values were within normal acceptable limit.

The ratio of roughage to concentrate varied from farm to farm (two farms on 80%:20% ratio; two farms on 70%:30% ratio; two farms on 60%:40% ratio and two farms on 50%:50% ratio). Napier grass (Taiwan and Indian varieties), Setaria grass and Brachiaria humidicola were the only improved grasses utilized for feeding the animals. Local grasses available in the farm vicinity were mainly Ottochloa nodosa, Echnocloa crus galli, Echinocloa colona and Crotus hirtus. Salt blocks were not given to the dairy goats, except those in farm F. The small farmer in farm G was considered innovative as DCP, zeolite and egg shells were utilized as mineral supplements at the ratio of 1.0: 0.25 and 0.25 respectively, at the inclusion level of 1.5% of the goat's daily diets. Occasionally, farm H in Tanah Merah, capitalized own grown leguminous plants as additional protein sources as well as oil palm fronds (OPF) as additional fibre sources. Apart from improved grasses (Napier, Setaria and Brachiaria humidicola), common feed used by the farms included commercial goat pellet A and B, PKC, soya bean meal, soya waste, wheat pollard and soya hull.

Table 5 shows the nutritive value of feedstuff used for feeding the dairy goats shows that goat pellets A and B contained between 16.0–17.0% CP, while the three improved grasses contained between 7.38 – 9.0%. The CP content in Indian Napier was 13.07% while in local grasses it ranged from 19.1 – 27.1%. The values of CP in local grasses can be considered very high as normally the level is in the range from 8 to 12% only (Wan Zahari et. al., 1985). On the other hand, CF of >25% in improved and local grasses is indicative of over matured which can result in reduced protein digestibility. Lower NFE values in forages is in line with their reduced soluble carbohydrates, which can also affect digestibility of other nutrients.

Table 5: Nutritive value of feedstuff used for feeding the dairy goats (% DM).

Feedstuff	DM (%)	CP (%)	CF (%)	EE (%)	NFE (%)	Ash (%)	GE (cal/g)
Goat pellet A	94.4±1.00	17.00±0.08	18.2±2.00	3.60±0.13	48.7	6.94±0.32	0.984±0.02
Goat pellet B	96±1.11	16.00±0.24	16.30±1.60	5.11±0.19	51.1	6.52±0.18	1.01±0.032
Soya bean hull	97.1±1.13	15.31±1.33	34.3±0.50	2.80±0.19	39.2	4.60±0.19	0.86±0.2
Setaria	23.7±1.43	8.00±0.11	33.2±0.03	1.23±0.05	31.4	12.03±0.63	0.95±0.005
Taiwan Napier	21.3±1.31	7.38±0.04	31.1±0.02	1.16±0.13	31.2	11.91±0.74	0.97±0.002
Indian Napier	20±1.21	13.07±0.09	32.4±0.01	0.92±0.52	39.6	12.31±0.47	0.89±0.0002
Brachiaria humidicola	21.3±1.22	9.00±0.19	33.23±0.07	0.73±0.05	37.1	14.52±1.06	0.93±0.031
Ottochloa nodosa	19.1±1.44	15.40±0.23	29.00±4.74	1.58±0.80	39.1	11.25±1.47	0.94±0.045
Echinochloa crus galli	22.4±1.23	14.4±0.50	30.00±2.24	1.45±0.60	37.2	12.72±0.63	0.99±0.023
Echinochloa Colona	27.1±1.42	17±0.50	26.6±4.43	1.59±0.66	31.0	11.87±0.35	0.99±0.02
Crotus hirtus	19.3±1.53	18±0.49	28.13±1.48	1.50±0.78	41.8	12.39±0.70	1.04±0.04

Note: DM: Dry matter, CP: Crude protein, CF: Crude fibre, EE: Ether extract, NFE: Nitrogen free extract, GE: Gross energy.

Both commercial pellets A and B contained high Ca (1.08 – 1.12%) and reasonable amount of Mg, K, Na, Fe, Mn and Zn (Table 6). However, both pellets contained high Cu (29 – 31 ppm) which had potential to cause Cu toxicity, especially in sheep. There is a great possibility that PKC is used as a main ingredient in commercial pellets A and B as PKC contains high Cu (25 ppm) (Wan Zahari and Alimon; 2003). Ca, Mg, K, Na, Fe, Cu, Mn and Zn concentrations in all of the improved and local grasses were found within normal acceptable ranges (Al-Khayat et. al., 2012). However, the adequacy of DMI to meet daily nutrient requirements is still very important during lactation.

Table 6: Mineral concentrations in some of the feedstuffs used feeding the dairy goats.

Feedstuff	Ca (%)	Mg (%)	K (%)	Na ((%)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
Goat pellet A	1.12	0.13	1.39	0.03	291	31	21	41
Goat pellet B	1.08	0.10	1.34	0.04	283	29	16	39
Ottochloa nodosa	0.49	0.23	1.68	0.10	279	4.0	8.1	32
Taiwan Napier	0.3	0.19	1.3	0.04	34	6.8	30	39
Indian Napier	0.3	0.21	1.73	0.03	37	5.7	33	43
Soya bean hull	0.61	0.04	1.7	0.01	324	12	26	24

Estimated DMI was calculated based on the daily intake of the diets by the animals in each farm and the dry matter content of each ingredient in their feed mixture. Animals in farms C, D, F and G were found in excess of targeted DMI with percentage differences of 18.8%, 12%, 38% and 2.6% respectively (Table 7). Increased milk yield in animals in Farm F was clearly attributed to excess DMI and enhanced nutritive values, more over with 50:50 ratio of grass to concentrate as compared to other farms. This had also resulted in improved BCS (4.0) and daily milk yield which ranged from 2.5 – 4.0 litres / day. On the other hand, DMI of the animals in farms A, B, E and H were found below the targeted DMI with percentage differences of (-) 17%, (-) 17%, (-) 12% and (-) 6% respectively.

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It is interesting to note here that two small holders from this study (Farm A and B) were observed to soak the pellets with water with the aim to enhance appetite and intake of the animals. This practice is not advisable in terms of dairy goats production as the total dry matter supplied will be diluted, which subsequently could affect milk yield and milk quality.

Table 7: Mean Live Weight, Estimated Dry Matter Intake and Average Milk Yield between Farms.

Farm	Location (Village/ District)	No of Lactating goats	Body weight (kg)+	Mean LW (kg)	Type of concentrate / commercial feed given	Average milk yield (litre/day)@	Estimated DMI (kg)	Targeted DMI (kg) *	Percentage Difference
A	Kg. Tar Tujuh, Pasir Mas	10	35 – 40	37.5	Pellet A (0.5kg)	1.5 – 2.0	1.25	1.50	17% (-)
B	Kg. Tar Tujuh, Pasir Mas	10	35 – 40	37.5	Pellet B (0.5 kg)	1.0 – 1.5	1.25	1.50	17% (-)
C	Kg. Tar Tujuh, Pasir Mas	10	35 – 45	40	Soya hull (0.5 kg) Pellet A (0.5 kg)	2.0 - 2.3	1.90	1.60	18.8% (+)
D	Kg. Tar Tujuh, Pasir Mas	10	35 – 50	42.5	Soya hull (0.5 kg) Pellet A (0.5 kg)	1.5 – 2.0	1.90	1.70	12% (+)
E	Kg. Tar Tujuh Pasir Mas	10	35 – 50	42.5	PKE (0.5 kg) Soya bean meal (0.5 kg)	1.5 – 2.0	1.50	1.70	12% (-)
F	Ketereh	10	35 – 50	42.5	Soya waste (1.0 kg) Pellet B (0.50 kg) Wheat pollard (0.5 kg) Salt block	2.5 – 4.0	2.35	1.70	38% (+)
G	Pantai Cahaya Bulan, Kota Bharu	10	45 – 50	47.5	Own mixture (1.5 kg)	2.0 – 3.5	1.95	1.90	2.6% (+)
H	Kemahang, Tanah Merah	10	35 – 45	40	Soya hull (0.5 kg) Pellet A (0.5 kg)	2.0-2.5	1.50	1.60	6% (-)

@Milk yield was measured by difference in weight
** Calculated based on 4.0% of mean live-weight of lactating goats.*

3.2. Dietary supplementation

The supplemented animals in groups A, B, C and E actually received high energy fatty acids which were originated from 100% RBD palm stearin. Both products were marketed as highly digestible energy source which is expected to improve feed conversion efficiency (FCE) and increased milk yield of dairy animals. EXTIMA STAR (supplemented to farm C) was also a rumen protected fat (containing 86% fat with ME and Ca % of 6.8 Mcal/kg and 9 % respectively) (Table 8). On the other hand, ORGACIDS (supplemented to farm E) is a feed additive in the form of organic acids which in ruminant animals can be used to increase milk production. This organic acids is widely known as a long acting acidifier, especially in non-ruminant animals. POWERMINR 4 CW/CATTLE + P is a chelated, mineral supplement and is marketed as a commercial feed ingredient in the form of [Zn – Mn – Cu – Co] and [amino acid complex] at the ratio of 1:1. The respective concentration of Zn, Mn, Cu, Co and amino acid complex are 5.06%, 2.80%, 1.76%, 0.18% and 10.24% respectively. It is aimed at enhancing milk production of dairy animals, apart from improving growth rate and reproductive performance of animals.

Farm F was supplemented with a mixture of EXTIMA 100 and EXTIMA STAR at the ratio of 50:50 and the objective was to enhance energy content of the ration in order to increase milk yield of dairy goats. Apart from the supplements, all animals in the supplemented groups received equal amounts of PKC, NaCl, CaCO3, and zeolite and mineral-vitamin mixture. PKC is rich in energy, protein, P and Cu (Wan Zahari and Alimon, 2003) whereas NaCl and CaCO3 provide Na and Ca respectively. Mineral - vitamin premix provided specific minerals and vitamins to the growing goats whereas zeolite has potential to enhance their nutrient digestibility.

There were no significant differences in the blood of non-supplemented groups between farms. The mean total WBC, RBC, HGB and HCT for this group regardless of the farms were 11.42 x 103, 3.60 x 106, 8.41g/dl and 41.3% (Table 9). The respective values for the supplemented groups were 11.51x 103, 8.40x 106, 8.37 g/dl and 23.4% (Table 10).

However, between farms, significant differences (P<0.05) were observed in the supplemented groups in the concentrations of GRA, HGB, HCT, MCV and MCH. Farm A that received EXTIMA 100, were seen higher in the concentrations of GRA, RBC, MCV and MCH as compared to other farms; while the concentrations of HGB and HCT were otherwise. Why and how EXTIMA 100 supplementation affecting this results is not clear, as its nutritive value is comparable to other energy supplements tested, except the chelated minerals, POWERMIN 4 COW/CATTLE + P.

Table 8: Nutritive values and characteristics of commercial fatty acids.

	EXTIMA 100	EXTIMA 300	EXTIMA STAR
Total fatty acids	99.5%	94%	86%
Free fatty acids(as palmitic)	1.0%	2.0%	-
Moisture and impurities	0.5%	0.5%	-
Slow melting point	56-60^{o} C	56^{o}C	-
Iodine value	24 max	24	-
Colour	Off- white	Creamy yellow	Light yellowish
Physical appearance	Powder/granular	Powder/granular	Granular
Dry matters	100%	100%	100%
C14:0 myristic acid	0-3%	0-3%	1.2%
C16:0 palmitic acid	70-80%	70-80%	4.7%
C18:0 stearic acid	5-10%	5-10%	5%
C18:1 oleic acid and higher	Approx. 8-12%	8-15%	-

Source: sales@erafeed.com

Table 9: Blood profiles in the not-supplemented groups between farms (Mean ± standard deviation).

Farm	TWBC (10^3/µl)	LYM (10^3/µl)	MON (10^3/µl)	GRA(10^3/µl)	RBC(10^6/µl)	Hgb (g/dl)	Hct (%)	MCV (fl)	MCH (Pg)	MCHC (g/dl)	PLT (10^3/µl)	MPV (µm^3)	PCT (%)
A	9.6±3.36^{a}	2.69±1.91^{b}	0.41±0.10^{a}	6.1±3.06^{a}	3.6±0.47^{a}	7.4±0.67^{b}	40.53±6.00^{a}	18.5±0.31^{a}	3.41±0.28^{a}	18.3±1.64^{b}	520 ±280.8^{a}	4.20±0.13^{a}	0.20±0.13^{a}
B	12.6±5.61^{a}	4.2±4.00^{a}	0.5±0.28^{a}	8.0±2.73^{a}	3.6±0.58^{a}	8.03±1.02^{a}	41.5±6.00^{a}	19.0±0.91^{a}	3.7±0.41^{a}	20±2.1^{a}	450±188^{a}	12.00±16.00^{a}	0.19±0.01^{a}
C	8.4±2.71^{a}	1.73±0.31	0.30±0.11^{a}	5.7±1.65^{a}	3.6±0.35^{a}	7.21±0.40^{a}	41.5±4.71^{a}	18.6±0.92^{a}	3.3±0.26^{a}	18±1.9^{a}	326±226.1^{a}	4.04±0.13^{a}	0.16±0.10^{a}
D	12.3±4.12^{a}	3.3±2.63^{a}	0.52±0.25^{a}	8.5±2.82^{a}	3.95±0.60^{a}	9.71±0.98^{a}	45.8±8.23^{a}	19.0±1.50^{a}	4.1±0.71^{a}	21.3±5.1^{a}	1573±3606^{a}	4.3±0.311^{a}	0.19±0.16^{a}
E	11.83±2.50^{a}	1.83±0.93^{a}	0.50±0.10^{a}	9.5±1.53^{a}	3.45±0.88^{a}	7.73±1.30^{a}	39.3±10.11^{a}	18.7±0.60^{a}	3.8±0.82^{a}	20.4±5.00^{a}	458.7±91.4	4.3±0.47^{a}	0.16±0.03^{a}
F	13.8±5.60^{a}	6.20±4.42^{a}	0.54±0.22^{a}	7.54±2.41^{a}	3.3±0.72^{a}	10.4±2.90^{a}	39.3±8.13^{a}	18.63±0.95^{a}	8.3±12.4^{a}	27.3±5.3^{a}	421.5±271^{a}	8.06±9.01^{a}	0.13±0.100^{a}
M±SD	11.42±4.00	3.33±2.40	0.46±0.20	7.6±2.40	3.60±0.60	8.41±1.21	41.3±7.20	18.74±0.89	4.44±2.50	20.9±3.51	624.9±777.2	6.20±4.34	0.20±0.07

*Values with different superscripts differ significantly P<0.05

Table 10: Blood profiles in the supplemented groups between farms (Mean ± standard deviation).

FARM	TWBC(10^3/µl)	LYM (10^3/µl)	MON (10^3/µl)	GRA(10^3/µl)	RBC (10^6/µl)	Hgb (g/dl)	Hct (%)	MCV (fl)	MCH (Pg)	MCHC (g/dl)	PLT (10^3/µl)	MPV (10^3/µl)	PCT (%)
A	11.71±2.61^{a}	4.6±1.7^{a}	0.84±0.23^{a}	6.32±1.24^{b}	10.1±6.00^{b}	6.2±0.90^{b}	19.8±9.2^{b}	23±6.5^{b}	9.23±6.6^{b}	38±17.5^{a}	656±411^{a}	9.8±14.2^{a}	0.31±0.91^{a}
B	16.2±8.00^{a}	7.0±4.9^{a}	1.02±0.47^{a}	9.0±3.0^{a}	14.1±6.00^{a}	7.8±1.01^{a}	30.2±5.24^{a}	19.0±0.51^{a}	4.8±0.50^{a}	25.4±3.00^{a}	461.4±236.2^{a}	5.04±0.32^{a}	0.23±0.12^{a}
C	12.3±6.1^{a}	5.6±4.00^{a}	0.90±0.32^{a}	6.5±2.2^{a}	8.9±5.4^{a}	8.0±1.23^{a}	22±7.8^{a}	30.3±14.0^{a}	12.0±7.1^{a}	37.4±12.2^{a}	670±439.2^{a}	4.8±0.2^{a}	0.32±0.22^{a}
D	10.12±3.61^{a}	5.2±2.5^{a}	0.82±0.40^{a}	5.0±2.2^{a}	4.8±1.0^{a}	8.0±2.3^{a}	24±12.8^{a}	31.7±8.2^{a}	17.9±7.00^{a}	40.2±16.4^{a}	1433±1477^{a}	7.5±2.0^{a}	0.37±0.24^{a}
E	9.3±1.06^{a}	4.6±0.5^{a}	0.80±0.10^{a}	5.0±1.00^{a}	7.4±1.0^{a}	7.0±0.80^{a}	12±2.1^{a}	20.4±0.95^{a}	10±1.60^{a}	41.0±25.7^{a}	1138±1514^{a}	7.1±2.1^{a}	0.67±0.78^{a}
F	9.4±2.33^{a}	5.3±1.5^{a}	0.80±0.30^{a}	4.7±2.1^{a}	5.0±1.06^{a}	13.2±3.0^{a}	32.6±11.9^{a}	17.4±1.00^{a}	5.9±1.20^{a}	24.0±8.2^{a}	220±59^{a}	9.0±1.3^{a}	0.58±0.30^{a}
M±SD	11.51±4.00	5.40±2.52	0.9±0.30	6.09±2.00	8.40±3.41	8.37±1.54	23.4±8.20	24.0±5.20	10.0±4.00	34.3±14.0	763.1±689.4	7.21±3.40	0.41±0.43

*Values with different superscripts differ significantly P<0.05

When all of the data from the not-supplemented and supplemented groups were combined and separately analysed, the latter groups were observed to be significantly (P<0.05) higher in the LYM, MON, RBC, MCV, MCHC and PCT than the former group. Likewise, the concentration of GRA, HGB, HCT and MCH were significantly (P<0.05) higher in the former group as compared to the latter group (Table 11). Apart from the

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effect of nutrient supplementation, the improvements of the blood parameters could also be due to the effects of deworming activities which were carried out before the commencement of the trial. The benefits of deworming in improving the blood parameters of the infected animals had been well established (Knox, 1996). It has also been cited that the faecal egg count of the infected animals were markedly reduced with the use of medicated urea-molasses mineral blocks (UMMB) as compared to the control (Wan Zahari et al., 2003). The provision of the supplements in the form of a concentrate mixture has also improved the animal's health status (Knox and Wan Zahari, 1998). In addition, the "cut and carry" or "zero grazing" which is the practice of the farms in this study, has a remarkable impact on the health of the animals (Khadijah et al., 2006). The WBC in particular, were within the normal range prior to and after the nutrient supplementations, indicating that the animals were stabilized and in healthy condition (Soetan and Akinrinde, 2013). Similarly, significant changes between the RBC before and after supplementation is highly associated with the nutrient supplementation that boost the physiological status of the animals and improvements with the bodily requirements (Isaac et al., 2013).

Table 11: Comparative blood profiles between the not-supplemented and supplemented groups (all farms combined) (Mean ± standard deviation).

Farm units	TWBC (10^3/µl)	lYM (10^3/µl)	MON (10^3/µl)	GRA (10^3/µl)	RBC (10^6/µl)	Hgb (g/dl)	Hct (%)	MCV (fl)	MCH (Pg)	MCHC (g/dl)	PLT (10^3/µl)	MPV (µm^3)	PCT (%)
Not-supplemented	11.82±4.81^a	3.95±3.53^a	0.47±0.22^b	7.4±2.70^a	3.50±0.61^b	8.8±2.12^b	41.3±7.16^b	18.7±0.94^b	6.9±0.95^b	21.7±5.33^b	631±1501^a	6.8±8.72^a	0.2±0.11^a
Supplemented	11.4±4.73^a	5.30±2.73^b	0.86±0.30^c	6.00±2.30^b	8.2±5.1^c	8.7±3.24^a	25.0±11.0^c	23.4±9.12^c	9.51±6.30^c	33.1±14.6^c	658±759.3^a	7.33±6.50^a	0.41±0.30^b

Values with different superscripts differ significantly P<0.05 by the use of T test.

Though there were significance changes in HBG before and after supplementation, the levels were considered low and could be linked to normocytic hypochromic anaemia and the Fe deficiency (Aster, 2004). Before the nutrient supplementation, the haematocrit was within the normal range. However, after the trial, it was observed to decrease drastically, signifying the level of anaemia that could be highly associated with Fe deficiency, as the result of parasite infestation. It is also likely that parasite resistance has started manifesting by the drugs used. In the first herd health screening carried out before the implementation of the current trial, the MCV and MCHC also indicated a normocytic hypochromic anaemia, which with nutrient supplementation and deworming had improved to normocytic normochromic (Rifkind and Cohen, 2002).

Table 12 and Table 13 show the plasma mineral concentrations in the not-supplemented and supplemented groups between farms respectively show comparative plasma mineral concentrations between the not-supplemented and supplemented groups by combining the data from the farms.

Table 12: Plasma mineral concentrations in the not-supplemented groups between farms (Mean ± standard deviation).

FARM	Ca (9-11mg/dl)	Mg (1.7-2.8mg/dl)	P (6-9mg/dl)	Na (3170-3360mg/L)	K (148-215mg/L)	Cu (0.7-1.4 ppm)	Zn (0.5-1.2 ppm)
A	8.3±0.6^b	2.64±0.20^a	6.0±0.78^a	2487.2±106^a	199.8±80.2^a	0.90±0.23^a	0.7±0.24^a
B	8.9±1.4^a	2.51±0.30^a	8.0±2.44^a	2623±693.2^a	198±75.0^a	0.75±0.27^a	0.66±0.30^a
C	8.2±1.74^a	2.4±0.24^a	7.4±1.20^a	2126±631.2^a	154.2±27.2^a	0.79±0.20^a	0.50±0.19^a
D	10.3±1.12^a	2.9±0.94^a	6.2±2.7^a	2607±305.5^a	177.4±18.2^a	0.60±0.40^a	0.6±0.44^a
E	8.0±0.4^a	3.1±1.02^a	5.7±0.59^a	2943.3±936^a	165.3±20.2^a	0.63±0.22^a	0.38±0.06^a
F	9.3±0.64^a	2.8±0.30^a	6.55±1.8^a	2485±680.9^a	205.3±93^a	0.66±0.27^a	0.69±0.40^a
M±SD	8.83±1.00	2.73±0.50	7.00±1.60	2545.2±559	183±52.3	0.72±0.27	0.60±0.30

Values with different superscripts differ significantly P<0.05.

The respective mean plasma Ca, Mg, P, Na, K, Cu and Zn concentrations for the supplemented groups were 9.00, 6.03, 2.42, 3025, 165, 0.73 and 0.56. Significant difference (P<0.05) in the supplemented group between farms was only observed in plasma P concentration whereby farm A showed the second lowest (5.5 mg/dl) as compared to other farms, except farm F (4.90 mg/dl). It is likely that supplementation of EXTIMA 100 and EXTIMA 100 plus EXTIMA STAR could cause marginal P deficiency in animals in farm A and F respectively. The high concentration of saturated fatty acids, notably of palmitic acid (C16:O) and stearic acid (C18:O) in EXTIMA 100 could possibly depress P utilization in the supplemented animals and the depression will be more severe with increased concentration of Ca, as EXTIMA STAR contains excessively high Ca (9%). The relationship between both saturated fats and Ca on P metabolism in animals has been well established.

When the data from all farms were combined regardless of the type of nutrient supplement given, the group with supplementation was found significantly (P<0.05) higher in plasma Na (3041 mg/L) concentration than those not supplemented (2522 mg/L). Similar trend was also observed in plasma Zn, though the difference was insignificant (Table 14).

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Table 13: Plasma mineral concentrations in the supplemented groups between farms (Mean ± standard deviation).

FARMS	Ca (9-11mg/dl)	Mg (1.7-2.8mg/dl)	P (6-9mg/dl)	Na (3170-3360mg//L)	K (148-215mg/L)	Cu (0.7-1.4 ppm	Zn (0.5-1.2 ppm)
A	9.0±1.04 ^{a}	3.0±1.7 ^{a}	5.5±1.09 ^{b}	3069.2±313.7 ^{a}	185.7±57 ^{a}	0.8±0.2 ^{a}	0.59±0.19 ^{a}
B	9.0±0.7 ^{a}	2.6±0.9 ^{a}	5.8±1.20 ^{a}	3020±240 ^{a}	173.4±37.3 ^{a}	0.64±0.32 ^{a}	0.44±0.12 ^{a}
C	8.8±1.04 ^{a}	2.3±0.6 ^{a}	7.1±2.01 ^{a}	3098±137.4 ^{a}	152±33.2 ^{a}	0.8±0.14 ^{a}	0.50±0.14 ^{a}
D	9.6±0.7 ^{a}	2.0±0.30 ^{a}	6.2±1.70 ^{a}	3072±233 ^{a}	175±22.6 ^{a}	0.60±0.30 ^{a}	0.7±0.34 ^{a}
E	8.8±0.61 ^{a}	2.34±0.70 ^{a}	6.7±0.72 ^{a}	2878±487 ^{a}	156±26 ^{a}	0.70±0.17 ^{a}	0.61±0.20 ^{a}
F	8.6±3.10 ^{a}	2.3±0.53 ^{a}	4.9±1.40 ^{a}	3011±1146 ^{a}	146±53.1 ^{a}	0.84±0.20 ^{a}	0.61±0.23 ^{a}
M±SD	9.00±1.20	2.42±0.79	6.03±1.40	3025±426.2	165±38.2	0.73±0.22	0.56±0.20

Values with different superscripts differ significantly P<0.05.

The main objective of this trial is to look at the effect of nutrient supplementation through enhancement of energy and to a lesser extent, protein and mineral concentrations on the milk yield as well as body condition of dairy goats. It is evident that provision of the above supplements did significantly (<0.05) improved daily milk yield of supplemented animals, with the mean of 2.9, 1.5, 2.4, 2.9, 2.8 and 2.9 litres /day as compared to 2.5, 1.4, 2.2, 2.5, 2.5 and 2.7 litres/day in the not-supplemented groups for farm A, B, C, D, E and F respectively (Table 15).

Table 14: Comparative plasma mineral concentrations between the not-supplemented and supplemented groups (All farms combined) (Mean ± standard deviation).

Farm	Ca (mg/dl)	Mg (mg/dl)	P (mg/dl)	Na (mg/L)	K (mg/L)	Cu (ppm)	Zn (ppm)
Not supplemented	8.9±1.50 ^{a}	2.7±0.60 ^{a}	7.1±2.02 ^{a}	2522±555 ^{b}	182.1±57.2 ^{a}	0.75±0.30 ^{a}	0.6±0.30 ^{a}
Supplemented	8.94±0.9 ^{a}	2.74±0.81 ^{a}	6.2±1.53 ^{a}	3041±275.2 ^{c}	170.1±38.0 ^{a}	0.70±0.23 ^{a}	0.92±0.60 ^{a}

Values with different superscripts differ significantly P<0.05

Though conservative and debatable, BCS of the animals were markedly improved in the supplemented groups as compared to those in the not-supplemented groups (Table 16). No change in BCS was observed in farms B and F, both in the not-supplemented and supplemented animals before and after the trial.

Table 15: Milk yield of the supplemented groups between farms (Mean ± standard deviation) n=60 animals.

FARM	A	B	C	D	E	F
Milk yield before supplementation +	2.5±0.04 ^{b}	1.4±0.41 ^{b}	2.2±0.01 ^{b}	2.5±0.01 ^{b}	2.5±0.01 ^{b}	2.7±0.01 ^{b}
Milk yield after supplementation++	2.9±0.20 ^{c}	1.5±0.17 ^{c}	2.4±0.11 ^{c}	2.9±0.16 ^{c}	2.8±0.16 ^{c}	2.9±0.01 ^{c}

Notes: + Mean of 15 days milk collection ++ Mean of 30 days milk collection
Values with different superscripts differ significantly P<0.05 by one-way Anova

Better understanding on dairy goat nutrition by the owner of Farm F could be the reason as to why the BCS of 4 was maintained (Table 2). The depression of BCS in Farm B is understandable which is due to limitation in feed supply and poor management of the animals. In general, the body coats of the supplemented animals were observed to be more shining than those in the not-supplemented animals, regardless of the farms. Lack of positive effects that attributed to nutrient supplementation in the present trial could be due to many reasons. Collection of data under smallholder's condition, especially on milk yield, is considered challenging as determination of daily milk yield was only done by difference in weight. It is also possible that the daily amount of supplements were inadequate to meet the increased demand of energy, protein and other nutrients for milk production. Except in farm F, the DMI from the basal rations received by the animals, were estimated to be only between 2.0 to 2.5% of the mean body weight. The estimated range of body weight of the animals in farms A, B, C, D and E were 35 – 40kg, 35 – 45kg, 35 – 50%, 35 – 50% and 35 – 50% respectively (Table 2). This can be considered inadequate to meet the nutrient requirements which usually require between 3.5 to 4.0% for the lactating dairy goats at mid lactation.

Table 16: Body Condition Score of the Not-Supplemented and Supplemented Groups between Farms.

Farm	Not-Supplemented		Supplemented	
	Before the Trial	After The Trial	Before The Trial	After The Trial
A	3.0	3.0	3.0	3.5
B	2.0	2.0	2.0	2.0
C	3.0	3.0	3.0	3.5
D	3.0	2.5	3.0	3.5
E	3.0	3.0	3.0	3.5
F	4.0	4.0	4.0	4.0

Most of the improved grasses used by the smallholders (namely Setaria and Napier grasses) were over matured (more than 8 weeks of age) and is highly less digestible. Moreover, even though 0.5 kg of concentrate or commercial pellets (A and B) were given per animal per day by the smallholders, the amount and the ingredients of the rations possibly fluctuated from day to day. Based on the discussion with the smallholders involved in this trial, the supply of concentrates and commercial pellets is inconsistent, mostly linked to high costs.

The percentage of improvement in daily milk yield were only 16%, 7%, 9%, 16%, 12% and 7% in farm A, B, C, D, E and F respectively. These values were considered low than the expected values of more than 25%

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as hypothesised before the implementation of the project. Commercial fatty acids, organic acids and chelated minerals supplementations (EXTIMA 100, EXTIMA 300, EXTIMA STAR; ORGACIDS and chelated-amino acid – minerals (POWERMINR 4COW/CATTLE+P) only contributed to small improvement in milk yield, which unjustified their usage under the smallholder condition owing to their less benefit to cost ratio. It is likely that these type of supplements are less suitable for increasing milk production in dairy goats, even though improvement in BCS can be observed. Palatability of the fat products should be seriously considered in dairy goat feeding as the animals are more sensitive to added fats than dairy cattle. Moreover, the added fats should be gradually increased in the ration allowing for palatability changes (tastes and odour) and microbial adjustment, especially when unsaturated fatty acids are used in the formulation (Titi et. al., 2011).

Unsaturated fatty acids are more likely to interfere with rumen fermentation than saturated fatty acids (Reno et. al., 2014). For any supplementary fat to be effective, adequate fibre and Ca are required in dairy animals. More research are therefore required on this aspect. The benefits of feeding various types of specialty fats and by-pass protein on milk production of dairy cows are well established (Andrews et. al., 1990; Reno et. al., 2014).

Sub-optimum production of the dairy animals under smallholder condition can be further enhanced by enriching their understanding on general dairy goat nutrition. These should include information on how to find and utilize good quality feedstuffs (including pastures), better feeding protocols and simple formulations. This knowledge are also important for the smallholders in developing more practical and cost-effective feeds. Apart from specialty fats and by-pass proteins, nitrogen (N) fixing fodder trees of importance have potential to be further introduced in the smallholder community. These include Gliricidia sepium, Sesbania grandifolia, Flemingia congesta and commonly available, Leucaena leucocephala and Kenaf (Hibiscus cannabinus) (Wan Zahari et. al., 2009).

4. CONCLUSION

Based on the findings of these two trials, it is evident that levels of nutrition for feeding dairy goats under smallholders dietary and management system vary in term adequacy in meeting the targeted DMI. The resources used in the feed mixtures by the smallholders were very few and mostly limited to two to three feedstuffs only. Napier grass is often utilized as a single source of roughage. Owing to these limitations; energy, protein and mineral requirements of these animals generally cannot be met, resulting in low milk yield and inferior body condition. In the first trial, daily milk yield of the animals at mid – lactation stage was found in the range of 1.5 to 2.5 litres only as compared to 3 – 4 litres in adequately fed goats. High ratio of forage to concentrate (40 – 80%: 60 – 20%) in daily feeds was one the factors that limit high milk yield of the dairy goats in Kelantan. The BCS of the animals were mostly below 3.0, which can be linked also to low milk yield. In general, poor performances of the animals are attributed mainly due to lack of knowledge on the nutrition and feeding of dairy goats by the smallholders.

Supplementation of selected commercial fatty acids, organic acid and chelated minerals at certain rates, even with additional input of nutrients through a formulated feed mixture, were found less effective in enhancing milk yield of the dairy goats under the smallholders feeding condition. Hence, the small increase in milk yield (i.e. between 12 to 16%) attributed to the above supplementations seem not practical and unjustified for smallholders, especially when cost of supplementation is considered. Though slight improvement in BCS of majority of the animals were achieved, positive effects of supplementation on blood profiling and plasma mineral concentrations cannot be realized.

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