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PALM OIL CA-SOAPS IN RUMINANT DIETS.1. DIGESTIBILITY, NITROGEN AND ENERGY UTILIZATION AND SOME RUMINAL AND BLOOD CONSTITUENTS

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ABSTRACT: **Twenty mature rams, being 2-3 years old and weighing an average of 80.26 kg were randomly distributed into five digestibility trail groups to evaluate the effects of protected and unprotected palm oil supplementation on nutritive values, nitrogen and energy utilization and some rumen and blood parameters. The experimental diets containing 0% (control), 2.5% unprotected palm oil (UPO), 5% (UPO), 2.5% protected palm oil (PPO) and 5% (PPO).**

The results showed no significant differences in total dry matter intake and digestibility coefficients of most nutrients among the tested diets except EE which showed significantly (P<0.05) high digestibility value with 5% PPO than that of the control. Fat supplementation significantly (P<0.05) increased the nutritive values as TDN and SV while, DCP values was not significantly affected. Also, digestible and metabolizable energy significantly (P<0.05) improved by fat addition than the control and not significantly affected by fat protection. The ruminal TVFA's and ammonia-N concentrations significantly decreased and pH values significantly increased with fat addition. However, fat protected recorded conflicting results. Blood serum urea and cholesterol values significantly (P<0.05) increased with fat supplementation, while total lipids and calcium concentration showed no significant differences, between the tested groups. On the other side protection of palm oil

significantly (P<0.05) increased phosphorus concentration compared with the values of unprotected palm oil groups.

Key words: Ca-soap, palm oil, digestibility, rumen parameters, sheep.

INTRODUCTION

Including fats in ruminant diets can increase the caloric density without reducing fiber contribution, and it can also increase energy consumption and efficiency of utilization (Espinoza *et al.*, 1998). Real increases in useful energy for ruminants depend on fat digestibility and on the effects of added fat on feed intake, digestibility, and utilization, of the rest of the feed components.

Fiber digestibility may be reduced when extra fat is fed (Jenkins and Palmquist, 1984, Jenkins et al., 1989 and Palmquist, 1994). The extent of the reduction in fiber digestibility increases as more fat is added. Fiber digestibility also depends on the fatty acid composition of the fats. The reduction is usually greater when the added fat is rich in unsaturated fatty acids (Palmquist, 1991). The protection of fats relatively inert the rumen and increase energy density and consumption and intend to suppress the negative effects on fiber digestibility without altering the microbial activity in the rumen (Palmquist and Jenkins, 1980 and Espinoza *et al.*, 1998).

The objective of this study is to evaluate the effect of using different levels of the protected and unprotected palm oil on feed intake, digestibility, nitrogen balance, nutritive value, energy utilization and some ruminal and blood parameters.

MATERIALS AND METHODS

This study was carried out at the Experimental Farm of Animal Nutrition Research Unit, Biological Application Department, Nuclear Research Center, Atomic Energy Authority. Abou-Zaable.

The experiment was designed to study the effect of feeding different levels of protected and unprotected palm oil on digestibility, Nutritive value, some rumen parameters, nitrogen balance, energy utilization and some blood parameters of sheep.

The Experimental Diets were

1- Control diet without any supplementation (basal diet).

2- Basal diet plus 2.5% (UPO).

3- Basal diet plus 5% (UPO).

4- Basal diet plus 2.5% (PPO)

5- Basal diet plus 5% (PPO).

Preparation of Calcium Salts of Fatty Acids

Ca-salts of palm oil were prepared following a double decomposition method (Deuel 1951). An antioxidant (0.2%, wt/ wt DL α-tocopheryl acetate; Hoffman-la Roch Ltd, Mississauga, ON, Canada) was added to the oil before manipulation to protect the unsaturated fatty acids from oxidation. The antioxidant properties of tocopheryl acetate were verified under out experimental condition. Four parts an aqueous solution of NaOH (6N) were then added to five parts of oil, and the hydrolysis of oil triacylglycerols was performed at 95 to 100°C with continuous mechanical agitation and bubbling N. When no more oil was visible, the resulting blend was left to stand at 5°C until Na soaps had solidified. The Na soaps then were dissolved in hot water (95 to 100°C) using 1: 5.6 ratio of soap to water, and a saturated solution of $CaCl_2$ was added for salting out. A tissue net was used to filter the Ca salts, and tap water was used to remove residual NaOH and excess $CaCl_2$. The Ca-salts were finally air dried in dark room, ground through a meat grinder, and kept at about -20°C until feeding. This process yielded salts that contained 92 to 93% total lipids, 6 to 7% Ca and <1% Na and Cl. After its preparation, it was crushed and mixed with the other components to form a mash diet.

Digestibility Trials

Five digestibility trails were conducted to evaluate the experimental diets. The experimental diets were formulated in Nuclear Research Center, Egyptian Atomic Energy Authority, and offered in mash form to cover the maintenance requirements of adult rams according to NRC (1985) allowances. The tested feeds were offered twice daily (8.00 am and 15.00 pm) water was available all time and rice straw was offered and libtum. Refused feeds were weighed and stored for proximate chemical analysis. The formulation and chemical composition of the tested diets are presented in Table 1.

Four mature local rams for every treatment with an average body weight of 80.26 kg were used. The digestibility trails lasted 28 days, 21 days as preliminary period, followed by 7 days as

collection period. Complete quantitative collection of feces and urine was carried out during each collection period. A daily sample representing 10% by weight of fresh feces from each animal was dried. Dried fecal and feed samples were ground and representative samples were taken for later analysis.

Chemical determination of representative feed samples using the A.O.A.C. (1984) procedures were done, and gross energy of the tested diets was determined using the programmable isothermal-jaket colorimeter (Julius peters, Berlin, West Germany) by the method illustrated by Nasr (1982) and Mostafa (1992). Urine was collected in containers to which 100 ml of 10% H_2SO_4 had been added to prevent any nitrogen losses. Urine volume was measured daily and a 10% aliquot was combined and stored for nitrogen determination by Kjeldahl method (Concon and Soltess 1973) by using an automatic electric buch 350.

Rumen Parameters

At the end of each digestibility trail, samples of rumen liquor were collected through stomach tube (rubber), via oesphagus from each animal before feeding and at 2, 4 and 6 hrs after feeding for determination of rumen pH, ammonia-N and TVFA'S concentration. The pH values were measured immediately after the collection and filtrations of rumen liquor through double layer of cheese cloth and before adding any preservatives using a pH meter (Digital pH meter CD–64 with glass electrode). Ammonia nitrogen was determined using the method of Conway (1957). Total volatile fatty acid concentration was determined according to Warner (1964).

Blood Parameters

Blood samples were collected at the end of digestibility trials. The samples were withdrawn from jugular vein before feeding and serum was separated by centrifugation of blood at 3000 rpm x 10 min. Serum samples were kept frozen at -20°C for later analysis. Total lipids and cholesterol were calorimetrically determined by using commercial kits (bio Merieux 69280 Marcy-1, Etoile / France). Calcium content in blood serum was determined using colorimetric method according to Ray Sarker, and Chauhan (1967). Phosphorus was determined by Atomic Absorption spectrophoto -meter according to

Jackson (1958). Urea was determined by enzymatic method according to Patton, and Crouch (1977).

Statistical analysis of data was analyzed using general linear modely using ANOVA procedures of SAS (1982).

RESULTS AND DISCUSSION

Dry Matter Intake

The results of dry matter intake per kg live body weight or kg metabolic body weight showed slightly insignificant increase with palm oil supplementation than the control value and with protected palm oil values than the unprotected ones (Table 2). Similar results were obtained by El-Bedawy *et al.* (1994).

Digestibility Coefficient:

The results showed that the nutrient digestibilities of DM, OM, CP, CF and NFE slightly insignificantly improved as a result of palm oil addition than the control values and showed no significant differences between protected and unprotected palm oil (Table2). However, the digestibility of EE significantly ($P<0.05$) increased with protected and unprotected palm oil addition than the control.

On the other hand the values of 5% protected palm oil showed significantly ($P<0.05$) higher values than the 2.5% unprotected ones, (Table 2). The results are in agreement with the results of Palmquist (1984), Nigidi *et al.* (1990) and El- Bedawy (1995).

Nutritive Values

The results of nutritive values as TDN, SE and DCP, (Table2) significantly increased as a result of supplemented protected and unprotected palm oil in comparison with the unsupplemented diet (control). The results showed significant differences between the nutritive values of protected and unprotected palm oil (Table2). Similar results were obtained by El-Bedawy *et al.* (1994) and El-Bedawy (1995) when sheep fed Ca-SFA supplemented diet.

Nitrogen Utilization

The results of nitrogen utilization as affected by protected and unprotected palm oil addition (Table 3) showed that fecal–N slightly insignificantly decreased. However, urinary–N significantly ($p< 0.05$) decreased by palm oil addition compared with the control ones which reflected on the values of total excreted–N. The results

also showed no significant differences between the values of protected and unprotected palm oil (Table 3).

The results of N-balance and the other nitrogen estimated values (Table 3) showed significant ($P<0.05$) improvement in N-utilization measurements as a result of supplemented palm oil than the unsupplemened one (control). Also, the results showed no significant differences between the values of treated and non treated palm oil (Table 3).

The results are in agreement with the results of Devendra and Lewis (1974), Palmquist and Conrad (1978) and Bunting *et al.* (1992).

Energy Utilization

The results of energy utilization as digestible energy (DE) and calculated metabolizable energy (ME) as affected by protected and unprotected palm oil addition (Table 4) showed that the daily excreted fecal energy significantly ($P<0.05$) decreased as a result of palm oil supplementation with out any significant effects of levels or form of palm oil supplementation (Table 3). The results of fecal excreted energy reflected on improving the values of DE an ME (MJ / h / d) and the quality factor (ME / GE) % as a result of palm oil addition, (Table 4). Similar trend were obtained by Hill and West (1991) and Zinn and Shen (1996) who found that added Ca-soap enhanced DE and NE values than barley or corn grain without addition.

Rumen Constituents

The results of some rumen parameters as affected by protected and unprotected palm oil supplementation showed that the ruminal total volatiel fally acids (TVFA) concentration significantly ($P<0.05$) increased up to 4 hours and ruminal- ammonia- N significantly ($P<0.05$) decreased up to 6 hours after feeding than before feeding. The ruminal pH values which significantly declined after feeding than before feeding (Table 5).

On the other hand, the results showed that the palm oil supplementation significantly ($P<0.05$) decreased the TVFA and ammonia-N concentrations and increased the pH values, the effect of palm oil protection showed conflicting results in the most tested rumimal parameters.

The results are in agreement with the results obtained by Boggsi

et al. (1987), Grummer (1988), Nigidi *et al.* (1990), Hill and West (1991), El-Bedawy *et al.* (1994) and Onetti *et al.* (2001) who reported conflicting results on the tested ruminal parameters.

Blood Constituents

The results of blood serum parameters (Table 6) showed that palm oil supplementation significantly ($P<0.05$) increased urea and cholesterol levels than the unsupplemented one (control). While, the values of total lipids and calcium showed no significant differences among the experimental groups. One the other side, the protected of palm oil did not show any significant effects on the tested parameters except the level of blood serum phosphorus which showed significantly higher values than the unprotected palm oil. The results are in a good agreement with Steele (1980), Bock *et al.* (1991), Mayes (1991), El-Bedawy (1995) and Espinoza et al (1995).

Conclusion

The results concluded that protected and unprotected palm oil supplementation at level 2.5% improved the nutritive values and performance of sheep without any adverse effects.

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Table 1: Formulation of the experimental diets and their chemical composition

Items	Experimental diets				
	Control	2.5% UPO	5% UPO	2.5% PPO	5% PPO
Yellow corn	34.8	31.3	27.8	31.3	27.8
Sugarbeet pulp	13.0	13.0	13.0	13.0	13.0
Wheat bran	25.0	25.0	25.0	25.5	25.5
Cotton seed meal	20.0	20.0	20.0	20.0	20.0
Soy bean meal	5.0	6.0	7.0	6.0	7.0
Palm oil	-----	2.5	5.0	-----	----
Protected palm oil	-----	---	----	2.5	5.0
Dicalcium phosphate	1.0	1.0	1.0	0.5	0.5
Comonsalt	1.0	1.0	1.0	1.0	1.0
Trace mineral *	0.1	0.1	0.1	0.1	0.1
VT.AD3E **	0.1	0.1	0.1	0.1	0.1
Chemical composition (%) on DM basis:					
(DM)	90.15	90.44	90.77	90.20	91.05
(OM)	94.59	94.57	94.54	95.07	94.96
(CP)	16.70	16.86	17.01	16.94	17.59
(CF)	10.32	10.20	10.37	10.42	10.41
(EE)	3.50	5.98	8.37	5.34	7.06
(NFE)	64.07	61.53	58.79	62.37	59.90
Ash	5.41	5.43	5.46	4.93	5.04
GE MJ/kg diet	16.99	18.89	18.95	18.82	18.57
Calculated chemical composition of consumed diets:					
CP	14.53	14.50	15.20	14.97	14.32
CF	15.25	15.53	14.40	14.81	17.36
EE	3.25	5.28	7.53	4.85	5.90
NFE	59.51	57.06	55.76	58.54	54.40

*Composition: Each/kg contains: Cu 3g, Iron 30g, Manganese 40g, Zinc 45g, Iodine 0.3g, Selenium 0.1g and $CaCO_3$ 881.6g

** Composition: Each 1kg contains: Vitamin A 20M.I.U, Vet. D3 2M.I.U. and VT.E 2gm.

Table 2: Effect of protected and unprotected palm oil supplementation on dry matter intake, digestibility coefficients and nutritive values

Items	Experimental diets				
	Control	2.5% UPO	5% UPO	2.5% PPO	5% PPO
Dry matter intake (g/h/d):					
CFM(g/h/d)	1167.1±6.18	1149.0±0.02	1138.6±14.03	1156.8±12.1	1117.25±33.29
Rice straw (g/h/d)	223.2±0.5^{ab}	240.4±44.25^{ab}	172.2±26.7^{b}	194.0±47.5^{b}	328.26±5.49^{a}
Total DMI (g/h/d)	1390.25±5.5	1389.4±44.25	131 0.8±31.06	1350.8±53.7	1445.5±31.10
DMI / Kg LBW	16.17±0.04	16.76±1.30	16.81±0.98	18.25±0.77	17.01±0.41
DMI /Kg $W0^{.75}$	49.23±0.11	52.85±3.28	49.97±2.41	53.60±1.7	51.64±1.02
Nutrient digestibility (%):					
DM	71.28±1.27	75.68±1.84	75.71±1.84	76.74±1.83	71.05±0.24
OM	75.22±0.67	78.94±1.68	78.71±1.69	77.80±3.01	75.03±0.25
CP	69.78±1.09	73.07±1.21	73.21±1.67	74.08±1.09	72.87±0.30
CF	50.10±0.52	52.28±2.05	50.43±2.35	56.97±3.82	50.36±0.46
EE	76.38±1.67^{c}	87.96±1.28^{b}	91.11±1.40^{ab}	92.12±1.04^{a}	93.80±0.76^{a}
NFE	80.23±0.83	82.77±1.51	82.56±1.34	80.63±3.23	79.13±0.21
Nutritive values on DM basis (%):					
TDN	71.1±0.16^{d}	76.91±1.03^{ab}	80.20±0.60^{a}	77.04±0.18^{b}	74.69±0.52^{c}
SE	65.21±0.23^{c}	70.35±0.98^{a}	72.73±0.74^{a}	70.37±0.16^{a}	67.7±0.82^{b}
DCP	10.14±0.16^{b}	10.60±0.18^{b}	11.13±0.25^{a}	11.09±0.16^{a}	10.44±0.04^{b}

a, b: Means in the same row having different superscripts differ significantly ($P<0.05$).

Table 3: Effect of palm oil and protected palm oil supplementation on nitrogen utilization of rams

Items	Experiments diets				
	Control	2.5% UPO	5% UPO	2.5% PPO	5% PPO
Nitrogen intake (NI) g/h/d	32.32±0.14	32.22±0.23	31.87±0.42	32.34±0.48	32.23±0.89
Daily excreted-N g/h/d:					
Fecal –N	9.77±0.39	8.68±0.44	8.18±0.58	8.39±0.45	8.74±0.26
Urinary –N	19.81±0.57^{a}	14.18±1.23^{b}	14.39±0.67^{b}	13.34±0.87^{b}	13.91±0.30^{b}
Total excreted –N g/h/d	29.58±0.28^{a}	22.86±1.21^{b}	22.57±1.22^{b}	21.73±0.87^{b}	22.65±0.41^{b}
Digestible–N (DN) g/h/d	22.55±2.78	23.53±0.28	23.32±0.41	23.95±0.19	24.15±0.11
N-blance g/h/d	2.74±0.39^{b}	9.35±1.09^{a}	9.06±1.11^{a}	10.60±0.86^{a}	10.24±0.37^{a}
NB / NI (%)	8.48±1.70^{b}	29.02±3.43^{a}	28.43±3.56^{a}	32.78±2.59^{a}	31.77±1.05^{a}
NB/DN (%)	12.15±2.28^{b}	39.74±6.57^{a}	38.85±4.14^{a}	44.26±4.70^{a}	42.40±0.67^{a}
NB (g/Kg BW)	0.03±0.02^{b}	0.12±0.02^{a}	0.12±0.02^{a}	0.14±0.01^{a}	0.12±0.02^{a}

a,b: Means in the same row having different superscripts differ significantly ($P<0.05$).

Table 4: The effect of protected and unprotected palm oil supplementation on digestible and metabolizable energy of rams

Items	Experimental diets				
	Control	2.5% UPO	5% UPO	2.5% PPO	5% PPO
Gross energy (GE) GE, MJ/Kg diets.	16.99	18.39	18.95	18.52	18.57
GE, intake MJ/h/d	23.61±0.10	25.78±0.87	24.84±0.52	25.02±0.86	26.85±0.61
Daily excreted energy:					
Fecal energy (FE) MJ /h/d	6.5±0.64^{a}	4.87±0.53^{b}	4.96±0.47^{b}	4.69±0.45^{b}	5.97±0.22^{ab}
(FE/GE) %	27.53±1.82^{a}	18.89±1.70^{b}	19.97±1.53^{b}	18.75±1.20^{b}	22.23±0.50^{b}
Digestible energy MJ/h/d	17.11±0.38^{b}	20.68±0.36^{a}	19.88±0.27^{a}	20.34±0.46^{a}	20.87±0.44^{a}
(DE/ GE) %	72.47±1.82	80.22±1.70	80.03±1.53	81.29±1.20	77.73±0.49
*Calculated metabolizable energy (ME) MJ/h/d	14.03±0.31^{b}	16.96±0.29^{a}	16.30±0.22^{a}	16.68±0.32^{a}	17.11±0.36^{a}
Quality factor (ME / GE) %	59.42±1.49^{b}	65.79±1.39^{a}	65.62±1.26^{a}	66.67±0.99^{a}	63.72±0.41^{a}

a, b, : Means in the same row having different superscripts differ significantly ($P < 0.05$).

*ME = DE x 0.82 (NRC, 1985).

Table 5: Effect of protected and unprotected palm oil supplementation on ruminal TVFA's, ammonia-N concentration and pH values of rams

	Diets					
Hours	**Control**	**2.5% UPO**	**5% UPO**	**2.5% PPO**	**5% PPO**	**Mean**
TVFAS concentration (ml eq /100 ml):						
0	18.13±1.91^{a}	9.6±1.51^{c}	9.50±0.53^{c}	13.23±0.69^{b}	6.18±1.27^{c}	11.33±1.18^{B}
2	14.05±0.73^{b}	12.68±0.77^{b}	12.70±0.24^{b}	19.98±0.91^{a}	10.33±0.94^{c}	13.95±0.09^{A}
4	18.60±0.51^{a}	9.6±1.45^{c}	14.78±2.34^{b}	20.30±0.42^{a}	10.13±0.10^{c}	14.69±0.96^{A}
6	15.68±0.64^{a}	6.2±0.72^{c}	13.38±1.90^{b}	11.83±0.24^{b}	7.35±0.47^{c}	10.89±0.79^{B}
Mean	16.62±0.95^{a}	9.53±0.79^{c}	12.59±1.25^{b}	16.34±0.57^{a}	8.50±0.70^{c}	---------
Ammonia-N concentration (mg/100ml):						
0	20.48±3.9	15.54±1.47	16.88±0.67	16.47±1.39	15.75±1.27	17.02±0.74^{D}
2	36.74±2.4	27.58±2.61	34.78±1.79	29.23±1.07	28.81±2.64	31.43±2.10^{A}
4	34.58±0.67	23.46±4.30	31.80±1.85	29.23±1.10	20.78±0.93	27.97±1.77^{B}
6	32.21±0.81	20.89±3.27	29.33±1.93	24.49±2.34	19.14±0.36	25.21±1.74^{C}
Means	31.00^{a}±1.95	21.87^{c}±1.78	28.20^{a}±1.56	24.86^{b}±1.48	21.12^{c}±1.3	---------
pH values:						
0	6.64±0.13^{cb}	6.87±0.03^{b}	7.22±0.14^{a}	6.60±0.08^{c}	7.26±0.07^{a}	6.92±0.09^{A}
2	6.31±0.4^{b}	6.24±0.06^{b}	6.30±0.07^{b}	6.39±0.15^{b}	6.85±0.03^{a}	6.42±0.08^{C}
4	6.17±0.02^{c}	6.92±0.10^{a}	6.15±0.06^{c}	6.59±0.12^{b}	6.91±0.05^{a}	6.55±0.06^{B}
6	6.57±0.04^{bc}	6.92±0.04^{a}	6.40±0.09^{c}	6.60±0.09^{bc}	6.79±0.14^{ab}	6.66±0.08^{B}
Mean	6.42±0.08^{d}	6.74±0.06^{b}	6.52±0.09^{c}	6.55±0.11^{c}	6.95±0.73^{a}	---------

a,b,c and d and A,B,C and D: Means in the same row and column respectively having different superscripts differ significantly ($P<0.05$).

Table 6: Effect of protected and unprotected palm oil supplementation on some blood serum parameters of rams

Items	Experimental Diets				
	Control	2.5% UPO	5% UPO	2.5% PPO	5% PPO
Urea-N mg/dl	37.5±2.35[b]	46.36±3.45[a]	49.29 ±2.48[a]	44.31 ±1.25[a]	50.21 ±1.45[a]
Cholesterol mg/dl	23.35±1.43[b]	23.79±0.35[b]	40.9±3.15[a]	37.4±2.49[a]	38.11±1.79[a]
Total lipids mg/dl	139.73±0.20	140.2±0.34	139.12±0.30	140.6±0.36	145.56±0.56
Calcium mg/dl	15.76±0.70	15.25±0.65	15.84±0.64	14.91±1.28	16.14±0.77
Phosphor mg/dl	6.14±0.56[a]	5.89±0.16[b]	5.23±0.67[b]	6.82±0.42[a]	7.73±0.69[a]

a, b, c: Means in the same row having different superscripts differ significantly ($P<0.05$).

زيت النخيل المحمى فى علائق المجترات ١. معاملات الهضم والاستفادة من النيتروجين والطاقة وبعض مكونات الكرش والدم

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أجريت هذه الدراسة باستخدام عشرين كبش ناضج عمر ٢-٣ سنوات ومتوسط وزن ٨٠,٢٦ كجم قسمة عشوائيا إلى خمس مجموعات تجريبية لدراسة أثر استخدام زيت النخيل المحمى وغير المحمى على القيم الغذائية واستخدام النتروجين والطاقة وبعض صفات الكرش والدم.

العلائق التجريبية:

١- عليقة مقارنة : بدون إضافة زيت.
٢- عليقة المقارنة + ٢,٥% زيت نخيل غير محمى.
٣- عليقة المقارنة + ٥% زيت نخيل غير محمى.
٤- عليقة المقارنة + ٢,٥% زيت نخيل محمى.
٥- عليقة المقارنة + ٥% زيت نخيل محمى.

وكانت نتائج البحث كالتالى:-

عدم تأثر المأكول من المادة الجافة الكلية ومعظم معاملات هضم المركبات الغذائية بالمعاملات التجريبية فيما عدا معامل هضم مستخلص الدهن مع مستوى ٥% زيت نخيل محمى زاد معنويا مقارنة بعليقة المقارنة.

إضافة زيت النخيل حسن معنويا من القيم الغذائية فى صورة مركبات كلية مهضومة ومعادل نشا.. بينما لم يكن هناك تأثير معنوى على البروتين الخام المهضوم ولم تظهر الحماية لزيت النخيل تأثير معنوى واضح على القيم الغذائية السابقة.

إضافة زيت النخيل أدت إلى انخفاض تركيزات الأحماض الدهنية الطيارة الكلية وأمونيا الكرش بينما زادت قيم الأس الهيدروجينى بشكل معنوى مقارنة بعليقة المقارنة... كان لحماية زيت النخيل تأثيرات متضاربة على صفات سائل الكرش المدروس.

إضافة زيت النخيل أدت إلى زيادة معنوية فى تركيزات اليوريا والكوليسترول فى سيرم الدم بينما لم تتأثر قيم الدهون الكلية والكالسيوم بشكل معنوى وكان للحماية تأثير معنوى على تركيز الفوسفور فى الدم مقارنة بقيم الزيوت غير المحمية.