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*in*

**Baselga M. (ed.), Marai I.F.M. (ed.).**
**Rabbit production in hot climates**

**Zaragoza : CIHEAM**
**Cahiers Options Méditerranéennes; n. 8**

**1994**
pages 111-123

# Using some of unusual waste vegetable oils as fat supplements in growing rabbit rations

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**SUMMARY** - The objective of this study was to evaluate two types of acidulated soapstock of either palm oil (APS) or mixture oils (AMS) in comparison with corn oil as a cheap supplemental fats when added at 1% to the commercial rabbit ration. Fatty acids profile of different fat types were determined by using GLC. The effect of additional fats was determined on growth response, nutrient utilization, blood serum metabolites and slaughter performance. Four groups of 60 weanling NZW rabbits (average body weight, 537±32 g) were given for 8 weeks a commercial diet without (control) or supplemented with 1% of any of: corn oil (group 2), acidulated palm oil soapstock (group 3) and acidulated mixture oils soapstock (group 4). The percentage of C18:2 (linoleic) in corn oil was higher than in AMS and APS. However, the percentages of C18:3 (linolenic) and C20:4 (arachidonic) were the highest in AMS and APS. The daily weight gain, feed conversion efficiency and viability of rabbits showed insignificant improvement with the acidulated soapstock diets. The digestibility of CF, percentage of N-retained, activity of GOT enzyme and dressing percentages were increased ($P < 0.01$ or $0.05$) by addition of the acidulated soapstock of either APS or AMS. Serum cholesterol level in rabbits was elevated ($P < 0.05$) with APS diet, while it decreased by AMS supplementation.

**Key words:** acidulated soapstock, palm oil, mixture, fatty acids profile, growth, digestibility, blood serum, slaughter performance.

## Introduction

Fats are the most concentrated sources of available energy used in poultry and nonruminant animals. Rabbits required fat in its diet as a source of essential fatty acids and to facilitate supply and absorption of the fat soluble vitamins (Clarke *et al.*, 1977). Moreover, it is well known that the high mortality percentages in rabbits in high-temperature environments are due to the weakness of rabbits against the heat stress. In order to aid the rabbits to withstand the effects of heat stress, one should consider carbohydrates and lipids as sources of energy for them in terms of attempting to reduce the relative heat increment per unit of ME (Edward, 1969 and Lipstein and Bornstein, 1974).

Although, vegetable oils have been used more often than animal fats to raise the lipid level in rabbit diet (Cheeke 1974, Beynen, 1988, Zeweil, 1990 and El-Gendy, 1993), however, it has been considered expensive fat supplements, especially in Egypt which most of the edible oils are purchases from the abroad. This led to search about alternative cheap sources are not used for human feeding. The acidulated soapstock or the acid oil is a by-product of edible oil refining contains a high proportion of free fatty acids, little neutral oil, in addition to phosphatides, some of biological active substances such as choline, tocopherol and carotinoides (Lipstein *et al*, 1965, 1970). The acidulated soapstock (acid oils) were used by some researches in poultry nutrition as additional fat source (Sibbald *et al*, 1962, Partridge *et al.*, 1986). However, the obtained results were conflicting, moreover, very little information are available about the using of such fat source in the rabbit rations.

The present study was designed to : 1) determine the fatty acids composition of acidulated soapstock of either palm oil or mixture oils (corn + sunflower + cotton seed) in comparison with the corn oil, 2) ascertain the effect of addition of 1% of such fat sources to commercial ration on growth response, digestibility of various ration components, blood serum constituents and slaughter performance, 3) calculate the economical efficiency of rabbits fed the different fat supplemented diets.

## Materials and methods

The present experiment was carried out in the Rabbit Research Unit, Department of Animal Wealth, Institute of Efficient Productivity, Zagazig University, Zagazig, Egypt, during the period from April, 21 to June 19, 1993.

A total of 60 weanling NZW rabbits of both sexs, 4 weeks of age of average initial weight 537±32 g were randomly allotted to four equal groups on the basis of body weight. Rabbits of the 1st group were given a basal diet (commercial); containing 17.1% crude protein, 12.9% crude fiber and 2.3% ether extract. The composition of the basal diet is presented in Table 1. The 2nd, 3rd and 4th groups were fed a basal diet supplemented with 1% of neutral corn oil, 1% acidulated palm oil soapstock

**TABLE 1**

**INGREDIENTS AND CHEMICAL COMPOSITION OF BASAL DIET FED TO GROWING RABBITS DURING THE EXPERIMENTAL PERIOD.**

| Items | % |
|---|---|
| Ingredients | |
| Ground barley | 20.00 |
| Ground alfalfa hay | 32.00 |
| Wheat bran | 25.30 |
| Soybean meal | 13.00 |
| Ground clover straw | 3.00 |
| Molasses | 4.85 |
| Bone meal | 1.00 |
| Premix (7957)* | 0.30 |
| Common salt | 0.40 |
| DL-Methionine | 0.15 |
| Total | 100.00 |
| Chemical composition (%)** | |
| Dry matter | 90.87 |
| Crude protein | 17.10 |
| Ether extract | 2.25 |
| Crude fiber | 12.85 |
| Nitrogen free extract | 50.97 |
| Ash | 7.70 |
| Calcium | 0.85 |
| Phosphorus | 0.59 |
| Lysine | 0.82 |
| Methionine + cystine | 0.60 |

* One kilogram of premix provides: vit. A, 20000 IU; vit. $D_3$; 150000 IU; vit. E, 8.33 g; vit K, 0.33 g; vit $B_1$, 0.33 g; vit $B_2$, 1.0 g; vit $b_6$, 0.33 g; vit $B_5$, 8.33 g; vit $B_{12}$, 1.7 mg; Pantothenic acid, 3.33 g; Biotine 33 mg; Folic acid 0.83 g; Choline chloride, 200 g; Zn. 11.7 g; Fe, 12.5 g; Cu, 0.5 g; I 33.3 mg; Se 16.6 mg, Mg 66.7 g; and Mn, 5 g.

** As fed basis.

(APS) and 1% of acidulated mixture oils soapstock (AMS), respectively. The different fat types were obtained from Misr Company for Soap and Oils, Zagazig, Egypt. The experimental animals were housed (each 2 together) in wire cages (60 x 55 x 40 cm) provided with galvanized feeders and automatic waterers. The rabbits were kept under the same environmental and managerial conditions. The different fat types were mixed carefully with basal diet just before distribution to prevent the lipid peroxidation. The experimental diets were offered daily to rabbits ad Libitum. The experiment extended for 8 weeks during which time individual live body weight and feed consumption were recorded at weekly intervals. At the final 10 days of the experiment, a digestibility trial was conducted by using 3 males from each group. Animals were housed individually in metabolism cages. The preliminary period was 4 days followed by 6 days for collection of faeces and urine and to calculate the feed consumption. Samples of daily faeces of each rabbit were taken and oven dried at 60 $^{o}$C for 48 h then ground and stored for the chemical analysis which was done according to AOAC (1980). Also, composite samples of daily urine were taken and stored in refrigerator at 5 $^{o}$C until analyzed for nitrogen. Samples of the different fat types were taken to determine the fatty acids composition by using of gas Liquid chromatography (Model: variant 3300; column ov. 101; temperatures of the column, injector and detector were 200, 280 and 240 $^{o}$C, respectively). Fatty acids were identified by comparison of retention times with standards and expressed as percentages of fatty acid methyl ester distribution. Percentages of identified fatty acids were determined by using of digital "Ushikata planimeter (Model DIGI PLAN 220P). The analysis of fatty acids was performed in the Laboratory of Department of Natural Products Chemistry, National Research Center, Dokki, Cairo, Egypt. Slaughter test was done at the end of the experiment by using of 3 animals from each group by cutting the carotid arteries and jugular vein. Rabbits were weighed just before slaughter as well as after complete bleeding. The head, skin and giblets (heart, liver and kidneys) were weight and proportionated to the live body weight, kidneys and abdominal fat were separated and weighed. Empty body weight and dressing percentages were also recorded. Blood sample from each rabbit was taken at the time of slaughtering into dry non-heparinized glass tube and blood serum was separated by centrifugation at 3000 r.p.m.

for 15 minutes. Serum was stored frozen in plastic vials until analyzed for cholesterol, total lipids, total protein, glutamate - oxaloacetate transaminase (GOT), glutamate - pyruvate transaminase (GPT), alkaline phosphatase (AKP), creatinine, calcium (Ca) and inorganic phosphorus (P). All the biochemical constituents in the blood serum were determined calorimetrically by using commercial kits purchased from both of Egyptian - American company of Laboratory Services and El-Nasr Pharmaceutical Chemicals Company, Cairo, Egypt. The economical efficiency (Y) and performance index (PI) were calculated according to the following equations: Y = ((A - B)/B) x 100, where A is selling cost of the obtained gain and B is the feeding cost of this gain. PI = (LBW/FC) x 100, where LBW is the live body weight expressed as kilogram and FC is the feed conversion efficiency (kg feed/kg gain). The metabolizable energy of the given diet (ME) was calculated according to the equation described by Kalogen (1985) as follow: ME (Kcal / kg feed DM) = (0.588 + 0.164 X) 239, where X is the digestion coefficient of feed dry matter. Data of the present study were analyzed by ANOVA as a completely randomized design (Snedecor and Cochran, 1982). Significant differences of means were tested using Duncan's multiple range test (Duncan, 1955). All the percentages data were transformed to their arcsin $\sqrt{\%}$ values for analysis. Viability was analyzed by using Chi-Square.

## Results and discussion

### 1. Analyzed fatty acids composition of corn oil and two types of acidulated soapstock.

Results of Table 2 indicate that the total percentage of unsaturated fatty acids in corn oil was higher than in the two types of acidulated soapstock. It represented 84% for corn oil versus 76.2 and 54.3% for acidulated mixture oil soapstock (APS) and acidulated palm oil soapstock (AMS), respectively. Therefore, the later fat types were fermer than the corn oil at room temperature. With regard to the essential fatty acids contents in different fat types, it could be observed that C18:2 was higher in corn oil (52.77%) than in AMS (17.42%) and APS (10.37%). However, the percentages of C18:3 (Linolenic) and C20:4 (arachidonic) were higher in AMS and APS compared to the corn oil. The previous results show that either APS or AMS are good sources for the essential fatty acids and can comparable to corn oil in this respect.

TABLE 2

ANALYZED FATTY ACIDS COMPOSITION[1] OF CORN OIL AND TWO TYPES OF ACIDULATED SOAPSTOCK.

| Fatty acid | Fat type | | |
|---|---|---|---|
| | Corn Oil | APS[2] | AMS[3] |
| Lauric | - | - | 3.46 |
| Myristic | 6.32 | - | 1.73 |
| Palmitic | 9.18 | 35.36 | 14.88 |
| Stearic | - | 10.34 | 3.46 |
| Oleic | 27.93 | 24.48 | 39.10 |
| Linoleic | 52.77 | 10.37 | 17.42 |
| Linolenic | 3.80 | 5.31 | 5.26 |
| Arachidonic | - | 7.24 | 12.42 |
| Others | - | 6.90 | 7.27 |

[1] As percentage of total methyl esters
[2] APS = Acidulated palm oil soapstock
[3] AMS = Acidulated mixture oils soapstock.

**2. Growth performance:**

Data of growth performance of rabbits fed the different fat types, during the 8th and 12th week of age are summarized in Table 3. Results indicate that daily feed consumption during the both periods was not significantly affected by addition of different fat types to the basal diet. Rabbits given the acidulated soapstock diets, either APS or AMS showed non significant improvements in the daily weight gain and feed conversion efficiency compared to those fed the control diet. The reduction observed in weight gain and feed conversion efficiency during the period of 8-12 weeks of age for rabbits fed the corn oil diets, may be due to diarrhea which affected rabbits during the indicated period.

Viability percentages were higher in rabbits fed the acidulated soapstock diets than in those fed the control, while it recorded the lowest percentage with rabbits given the corn oil diet (80% vs 86.7, 100 and 93.3% for the control, APS and AMS diets, respectively). The best performance index was recorded with rabbit given the AMS diet (60.4%) followed by those fed APS (56.9%), control (50.1%) and corn oil diets (51.3%). Economical efficiency was increased by 15.9% for rabbits fed AMS diet and by 10.7% for those given the APS diet, while it decreased by 9.2% for rabbits of corn oil group.

**3. Nutrients digestibility, feeding value of diets and nitrogen utilization:**

Data of the apparent digestibility, feeding value of the given diets and nitrogen utilization by growing rabbits are presented in Table 4. Dry matter intake was not significantly affected by addition of any of the different fat types to the basal diet (control). Addition of acidulated soapstock of either palm oil (APS) or mixture oils (AMS) improved the

TABLE 3

GROWTH PERFORMANCE ($\overline{X}\pm$S.E)[1] OF GROWING NZW RABBITS FED BASAL DIET SUPPLEMENTED WITH CORN OIL, ACIDULATED PALM OIL SOAPSTOCK AND ACIDULATED MIXTURE OILS SOAPSTOCK.

| Traits | Dietary groups | | | |
|---|---|---|---|---|
| | Control[2] | Corn Oil[3] | APS[4] | AMS[5] |
| | 4 - 8 weeks of age | | | |
| Number of rabbits | 15 | 15 | 15 | 15 |
| Initial body weight, (g) | 536.7±30.3 | 538.7±33.3 | 536.7±31.6 | 536.7±31.4 |
| Body weight at 8 weeks of age (g) | 1120.0±59.7 | 1212.1±53.0 | 1250.0±50.5 | 1214.3±60.3 |
| Daily body gain (g) | 20.8±1.2 | 23.7±1.3 | 25.5±1.5 | 23.8±1.6 |
| Daily feed consumption (g) | 67.0±12.4 | 70.7±9.3 | 68.4±11.5 | 74.4±11.5 |
| Feed conversion (g feed/g gain) | 3.22 | 2.98 | 2.68 | 3.12 |
| Viability (%) | 100 | 93.3 | 100 | 93.3 |
| Feed cost/kg gain (LE) | 1.642 | 1.617 | 1.394 | 1.622 |
| Economical efficiency (%) | 265.41 | 271.06 | 330.42 | 269.91 |
| Performance index (%) | 34.78 | 40.67 | 46.64 | 38.92 |
| | 8 - 12 weeks of age | | | |
| Body weight at 12 weeks of age (g) | 1865.0±52.2 | 1914.2±51.3 | 1934.7±62.1 | 1987.5±58.1 |
| Daily body gain (g) | 25.5±1.4 | 23.4±2.2 | 24.5±1.6 | 27.9±1.5 |
| Daily feed consumption (g) | 107.8±10.7 | 108.9±8.4 | 101.9±3.7 | 105.3±1.9 |
| Feed conversion (g feed/g gain) | 4.22 | 4.65 | 4.16 | 3.77 |
| Viability (%) | 86.7 | 86.7 | 100 | 100 |
| Feed cost/kg gain (LE) | 2.152 | 2.523 | 2.163 | 1.960 |
| Economical efficiency (%) | 178.81 | 137.81 | 177.39 | 206.12 |
| Performance index (%) | 44.19 | 41.17 | 46.51 | 52.72 |
| | 4 - 12 weeks of age | | | |
| Daily body gain (g) | 23.5±0.7 | 24.1±1.3 | 25.0±1.2 | 26.0±1.3 |
| Daily feed consumption (g) | 87.4±10.8 | 89.8±9.9 | 85.1±12.0 | 85.6±8.0 |
| Feed conversion (g feed/g gain) | 3.72 | 3.73 | 3.40 | 3.29 |
| Viability (%) | 86.7 | 80 | 100 | 93.3 |
| Feed cost/kg gain (LE) | 1.897 | 2.024 | 1.768 | 1.711 |
| Economical efficiency (%)[6] | 216.29 | 196.44 | 239.37 | 250.67 |
| Performance index (%) | 50.13 | 51.32 | 56.90 | 60.41 |

1 All the differences within the treatment groups were not significant (P > 0.05).
2 Basal diet (commerical ration).
3 Basal diet + 1% corn oil.
4 Basal diet + 1% acidulated palm oil soapstock.
5 Basal diet + 1% acidulated mixture oils (corn + sunflower + cotton seed) soapstock.
6 Based on that the price of one kilogram of basal, corn oil, APS and AMS diets was 0.51, 0.54, 0.52 and 0.52, respectively and the price of one kilogram of body weight at selling was 6.00 L.E.

TABLE 4

APPARENT DIGESTIBILITY, FEEDING VALUE AND NITROGEN UTILIZATION ($\bar{X} \pm SE$) BY GROWING NZW RABBITS FED BASAL DIET SUPPLEMENTED WITH CORN OIL, ACIDULATED PALM OIL SOAPSTOCK AND ACIDULATED MIXTURE OILS SOAPSTOCK.

| Items | Dietary groups | | | | Statistical significance |
|---|---|---|---|---|---|
| | Control | Corn Oil | APS | AMS | |
| **Live body weight (g):** | | | | | |
| Initial | 1883±44 | 1857±70 | 1833±60 | 1833±120 | NS* |
| Final | 2015±49 | 2001±75 | 2005±75 | 1987±87 | NS |
| Dry matter intake (g/head/day) | 110±4 | 98±5 | 108±9 | 90±2 | NS |
| **Digestibility coefficients (%):** | | | | | |
| DM | 62.2±4.3 | 61.5±1.7 | 67.5±0.2 | 66.2±1.3 | NS |
| OM | 63.8±4.2 | 64.3±2.1 | 68.4±0.3 | 67.3±1.3 | NS |
| CP | 73.8±1.4 | 78.3±3.2 | 80.8±0.4 | 77.5±1.9 | NS |
| EE | 81.7±3.2 | 82.6±4.0 | 87.1±1.9 | 81.0±2.1 | NS |
| CF | 28.8±1.3[b] | 26.6±1.2[b] | 34.7±1.5[a] | 36.3±1.7[a] | (P<0.05) |
| NFE | 68.5±2.6 | 67.8±1.1 | 71.6±0.3 | 70.9±0.9 | NS |
| **Feeding value of ration:** | | | | | |
| ME (Kcal/kg DM)** | 2580±171 | 2552±68 | 2786±10 | 2735±54 | NS |
| TDN (%) | 57.2±3.7 | 57.4±1.9 | 61.1±0.3 | 60.1±1.1 | NS |
| DCP (%) | 12.6±0.4 | 13.4±0.5 | 13.8±0.1 | 13.2±0.3 | NS |
| **Nitrogen utilization:** | | | | | |
| N-Intake (g/day) | 3.32±0.12 | 2.95±0.16 | 3.23±0.28 | 2.71±0.06 | NS |
| Faecal-N (g/day) | 0.87±0.05 | 0.64±0.13 | 0.62±0.04 | 0.61±0.04 | NS |
| Urinary-N (g/day) | 1.62±0.14 | 1.42±0.04 | 1.57±0.13 | 1.17±0.05 | NS |
| Apparent absorption (%) | 73.79±2.37 | 78.30±3.20 | 80.80±0.40 | 77.49±1.97 | NS |
| N-Retained (g/day) | 0.83±0.04 | 0.89±0.07 | 1.04±0.13 | 0.93±0.07 | NS |
| (% of intake) | 25.8±0.81[b] | 30.17±1.39[b] | 32.20±2.11[a] | 34.32±2.10[a] | (P<0.05) |

a,b Means in the same row with different superscripts significantly differ (P<0.05).
NS* = not significant.
** Metabolizable energy value (ME) was calculated according to Kalogen *et al.* (1985).

digestibility of various diet components. However the improvement was significantly ($P < 0.05$) only for the crude fiber digestibility which increased by 20.5 and 26.0% for APS and AMS diets, respectively compared to the basal diet. Increasing digestion coefficients of CF by addition of acidulated soapstock may be due to the high acidity of the later fat product, which play a role in breakdown of the celluletic components in the diet. The feeding value expressed as ME or TDN or DCP was higher for APS and AMS diets than the control diet, however, the differences were not significant. Although N-retained expressed as g/day was not differed within the treatment groups, nitrogen retained as percentage of total intake was higher ($P < 0.05$) in rabbits fed the acidulated soapstock compared to those fed the control diet.

It could be observed that addition of corn oil to basal diet had no remarkable beneficial effects on the apparent nutrients digestibility and in turn the feeding value of the given diet. This was in agreement with the findings of Lebas (1975) who noticed a decrease in the digestibility of dry matter, organic matter and energy when corn oil was added to the diet of rabbits. The authors suggested that addition of corn oil did not increase the digestible energy content of the diet because the maize oil had low digestibility.

**4. Blood serum metabolites:**

Data in Table 5 show that levels of the determined blood serum constituents were not significantly differed within the treatment groups, with exception of total cholesterol and GPT concentrations. Cholesterol level decreased ($P < 0.01$) by 25% with the addition of AMS, while it increased by 56.2% and 21.5% by addition of APS and corn oil to the basal diet, respectively. The elevation of total cholesterol level by addition of acidulated palm oil soapstock (APS) to the basal diet is due to the fact that palmitic acid presented in APS has hyperlipidemic and thus may increase the serum cholesterol (Keys *et al.*, 1965). In this connection also Pereira *et al.*, (1990) found that rats fed a palm oil diet exhibited a greater high density lipoprotein (HDL) cholesterol to total plasma cholesterol ratio than did animals fed a control diet. However, Solomon et al. (1992) reported that feeding of palm oil to rams did no result in elevation of longissimus muscle cholesterol levels even though serum lipid metabolites rose significantly with the addition of palm

**TABLE 5**

BLOOD SERUM CONSTITUENTS ($\bar{X} \pm SE$) OF RABBITS FED BASAL DIET (COMMERCIAL) SUPPLEMENTED WITH CORN OIL AND ACIDULATED SOAPSTOCK OF EITHER PALM OIL OR MIXTURE OILS.

| Items | Dietary groups | | | | Statistical significance |
|---|---|---|---|---|---|
| | Control | Corn Oil | APS | AMS | |
| Cholesterol (mg/dl) | $125.7 \pm 5.4^b$ | $152.7 \pm 4.4^c$ | $196.3 \pm 8.1^a$ | $94.3 \pm 7.8^d$ | (P<0.01) |
| Total lipids (g/L) | 5.4±0.3 | 5.7±0.9 | 7.0±0.6 | 7.0±0.5 | NS |
| Total protein (g/L) | 6.7±0.6 | 7.0±0.5 | 8.1±0.6 | 7.7±0.6 | NS |
| GOT (U/L) | 76.1±8.6 | 57.9±3.8 | 56.4±4.7 | 66.6±6.8 | NS |
| GPT (U/L) | $19.1 \pm 0.7^b$ | $12.5 \pm 0.9^c$ | $24.5 \pm 2.3^{ab}$ | $25.7 \pm 2.1^a$ | (P<0.01) |
| Alk. phos. (U/dl) | 30.2±0.4 | 29.1±3.8 | 29.4±0.1 | 30.7±2.4 | NS |
| Creatinine (mg/dl) | 2.0±0.1 | 2.0±0.2 | 1.7±0.4 | 1.3±0.2 | NS |
| Ca (mg/dl) | 10.8±1.5 | 10.6±0.1 | 12.2±0.6 | 11.3±0.7 | NS |
| P (mg/dl) | 3.7±0.6 | 3.8±0.5 | 4.5±0.5 | 4.4±0.3 | NS |

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

oil. The author had no explanation for the increasing of total cholesterol content in blood serum of rabbits fed the corn oil diet, although this fat type has a cholesterol lowering effect (El-Gendy, 1993).

The level of GPT enzyme was higher ($P < 0.01$) in serum of rabbits given the acidulated soapstock diets compared to the control rabbits and those fed the corn oil diet. However, these levels were within the normal levels. The observed normal levels of GOT, GPT, alkaline phosphatase and creatinine in blood serum of rabbits fed the acidulated soapstock diets, either APS or AMS indicate that these fat types had no deleterious effects on liver, heart and kidneys functions.

**5. Slaughter performance:**

Results in Table 6 show that rabbits given either APS or AMS diets has a dressing percentages higher ($P < 0.05$) than those fed the basal diet (control). Dressing percentages in rabbits of corn oil group were statistically similar to those of the control. Perirenal fat deposits was heavier ($P < 0.05$) in rabbits fed APS diet compared to rabbits of other treatment groups weights of giblets and abdominal fat as grams or

## TABLE 6

SLAUGHTER PERFORMANCE ($\bar{X} \pm SE$)* OF NZW RABBITS FED BASAL DIET SUPPLEMENTED WITH CORN OIL AND ACIDULATED SOAPSTOCK OF EITHER PALM OIL OR MIXTURE OILS

| Triats | | Dietary groups | | | | Statistical significance |
|---|---|---|---|---|---|---|
| | | Control | Corn oil | APS | AMS | |
| Preslaughter weight | (g) | 1993.3±47.03 | 1976.3±70.63 | 1976.7±65.74 | 1965.0±95.11 | NS** |
| Empty body weight | (g) | 1025.0±7.64 | 1026.67±8.02 | 1065.0±10.06 | 1195.0±11.55 | |
| | (%) | 51.42±1.15$^{b}$ | 51.95±1.23$^{b}$ | 53.88±1.45$^{ab}$ | 56.23±1.08$^{a}$ | P<0.05 |
| Giblets weight | (g) | 101.39±13.59 | 101.7±3.47 | 98.56±9.12 | 96.87±7.45 | NS |
| | (%) | 5.08±0.61 | 5.16±0.23 | 4.99±0.34 | 4.93±0.21 | |
| Liver | (g) | 82.84±6.95 | 83.85±2.82 | 71.95±8.16 | 79.82±6.64 | NS |
| | (%) | 4.14±0.59 | 4.25±0.22 | 3.62±0.32 | 4.06±0.59 | |
| Heart | (g) | 5.45±0.66 | 5.77±0.75 | 4.82±0.56 | 5.33±0.29 | NS |
| | (%) | 0.27±0.03 | 0.29±0.03 | 0.24±0.02 | 0.27±0.02 | |
| Kidneys | (g) | 13.08±0.53 | 12.09±0.37 | 11.79±0.42 | 11.73±0.87 | NS |
| | (%) | 0.66±0.04 | 0.61±0.02 | 0.59±0.01 | 0.59±0.02 | |
| Kidneys fat | (g) | 11.66±0.67 | 13.32±1.58 | 16.01±0.59 | 11.35±1.14 | P<0.05 |
| | (%) | 0.59±0.04$^{b}$ | 0.67±0.11$^{a}$ | 0.81±0.05$^{a}$ | 0.58±0.05$^{b}$ | |
| Abdominal fat | (g) | 5.93±0.28 | 5.29±0.29 | 7.72±1.19 | 4.53±0.78 | NS |
| | (%) | 0.30±0.01 | 0.27±0.01 | 0.39±0.08 | 0.23±0.05 | |
| Carcass weight | (g) | 1126.39±8.57$^{b}$ | 1128.38±7.23$^{b}$ | 1163.5±9.34$^{a}$ | 1201.87±10.53$^{a}$ | P<0.05 |
| Dressing | (%) | 56.51±1.06$^{b}$ | 57.10±1.31$^{ab}$ | 58.86±1.13$^{ab}$ | 61.16±1.26$^{a}$ | P<0.05 |

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

* Average of three samples were taken for each group.

** Not significant.

relative to preslaughter weight were unaffected statistically by dietary treatments. It is necessary to observe that although, the differences in final body weights at 12 weeks of age were not significant within the treatment groups (Table 3), rabbits fed the acidulated soapstock diets had a better slaughter performance than those fed basal or corn oil diets. The good slaughter performance of rabbits fed the acidulated soapstock diets may be due to fact that this fat type contains more saturated fatty acids than the corn oil (Table 2) which promote lipoprotein synthesis, whereas corn oil contains more polyunsaturated fatty acids which promote oxidation (Beynen and Katan, 1985).

## Conclusion

From an economical point of view and the previous results of the study, it can be recommended to use the acidulated soapstock of either palm oil or mixture oils (corn + sunflower + cotton seed) as a cheap supplemental fat in commercial rabbit rations under the conditions of Egypt. However, more studies are required to establish the optimum levels which can be used for such fat types in the rabbit rations.

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