# EFFECT OF DIETARY SUPPLEMENTATION WITH DIFFERENT TYPES OF PROTECTED FAT ON BIOPRODUCTIVE PERFORMANCES AND QUALITY OF CARCASS IN SHEEPS *

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***Abstract***
*The objective of this study is to determine the effect of dietary supplementation of intensive fattening lambs with different types of protected fat (calcium salts of fatty acids) on bioproductive performance and carcass quality. 32 lambs of 70-75 days of age, breed Tzigai were randomly assigned to four groups and randomly assigned to one of the following diets: C - fat diet without supplements; SO - diet supplemented with 4% sunflower oil, RO - diet supplemented with 4% rapeseed oil and GR - diet supplemented with 4% grease (% by weight). Supplementing the diet with different types of protected fat increased the weight gain to 1.12 kg / head in sample GR, by 2.15 kg in RO group and 3.36 kg in group SO, while food leverage has improved by 7.03%, 10.4% and, respectively, 14.72%. Protected fats in food have significantly improved efficiency at slaughter and eye muscle area, but has led to decreasing the proportion of meat and protein levels from meat (Nx6, 25) in favor of adipose tissue and fat (ether extract) of meat , which normally attracted an increase in DM content of meat.*

## INTRODUCTION

Fat, regardless of length of carbon atoms chain in the structure of fatty acids, is an efficient energy supplement for animals, being very digestible, with a high metabolic use and provides a better utilization of food nitrogen (Frast et. Wells, 2001; Cattier et. al., 2006). Fat high-energy level allows the increase of pulp proportion in the diet of fattening lambs, which ensures the proper functioning of the rumen during the initiation of fermentation activity (pH, digestive transit speed) and it allows the reduction of volatile fatty acids proportion, precursors of fatty acid responsible for the lack of consistency of fat from carcasses (Velasco et. al., 2001).

In addition, fats prevent ruminal acidosis, facilitate absorption of liposoluble nutrients and make it possible to modify meat fat composition according to consumer demand (Manso et. al., 2005).

Adding fat in the rations at a rate of 5-7% in DM provides increased lamb weight with 15 to 20% (Delmotte et. Al., 2004). Triglycerides that form the basis of fats are hydrolyzed in the rumen to form free fatty acids and glycerin. Glycerin ferments and turns to propionic acid, which is a precursor of glucose and amino acids, enhancing so, the protein synthesis.

At the same time the fats in ruminant nutrition leads to substantial reduction in the rumen and gases released into the environment.

Ngidi et. al., (1990) observed that apparent digestibility of fat increased, whereas true digestibility decreased when fat was added at up to 8% of diet DM. They concluded that 2 to 4% added fat may stimulate feed intake and increase DE intake of lambs.

A number of processes such as hydrogenation, conversion to calcium salt, prilling and encapsulation commonly used to modify lipid and minimize or even eliminate changes of fermentation in the rumen when fat is added to the ration (Hashem et. al., 2006). As they are "dry fats", calcium soaps facilitate fat inclusion in the diet and may also avoid some of the negative effects of dietary fats on ruminal fermentation (Grummer, 1988; Nigdi et. al., 1990; Jenkins, 1993). There have been several studies on effects of different fats of vegetable origin in diets of fattening lambs (Preziuso et. al., 1999; Russo et. al., 1999; Bas and Morand-Fehr, 2000; Machmuller et. al., 2000; Kott et. al., 2003; Ivan et. al., 2004).

The objective of this research deals with the effect of food supplementation for intensive fattening lambs, with different sources of fat (sunflower oil, rapeseed oil and grease) protected against rumenal fermentation by treatment with calcium salts (calcium salts of fatty acids) on bioproductive performances and quality of carcass and meat obtained.

## MATERIALS AND METHODS

Consistent with the objectives, research was conducted on a flock of 32 male lambs of 70-75 days of age (immediately after weaning), Tzigai breed randomly assigned into 4 groups of eight individuals each, corresponding to the four treatments:

- Group I - the basic diet without fat supplementing (C);
- Group II - the diet was supplemented with sunflower oil (SO);
- Group III - diet was supplemented with rapeseed oil (RO)
- Group IV - diet was supplemented with grease (GR).

Diets were supplemented with bypass type fat, obtained by treating them with calcium salts to prevent their hydrolysis in the rumen.

Bypass type fats were incorporated into food at a rate of 4% (% of TMR weight - total mixed ration) (Table 1).

*Table 1*

The structure and nutritional value of used single feed mixtures

| | Phase of growth (90 days) | | | | Finishing phase (20 days) | | | |
|---|---|---|---|---|---|---|---|---|
| | C | SO | RO | GR | C | SO | RO | GR |
| **a) TMR Structure (%)** | | | | | | | | |
| chopped alfalfa hay | 35,0 | 35,0 | 35,0 | 35,0 | 20,0 | 20,0 | 20,0 | 20,0 |
| corn | 27,0 | 21,5 | 21,5 | 21,5 | 34,0 | 29,2 | 29,2 | 29,2 |
| triticale | 10,0 | 10,0 | 10,0 | 10,0 | 15,0 | 15,0 | 15,0 | 15,0 |
| barley | 10,0 | 10,0 | 10,0 | 10,0 | 15,0 | 15,0 | 15,0 | 15,0 |
| soybean oil cake | 16,0 | 7,5 | 7,5 | 7,5 | 14,0 | 14,8 | 14,8 | 14,8 |
| Protected fat (calcium salts of fatty acids) | | | | | | | | |
| Sunflower oil | - | 4,0 | - | - | - | 4,0 | - | - |
| rapeseed oil | - | - | 4,0 | - | - | - | 4,0 | - |
| grease | - | - | - | 4,0 | - | - | - | 4,0 |
| vitamin-mineral premix | 2,0 | 2,0 | - | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 |
| **b)Nutritive characteristics** | | | | | | | | |
| - UNC (kg) | 0,87 | 0,90 | 0,90 | 0,90 | 1,00 | 1,02 | 1,02 | 1,02 |
| - P.b. (%) | 17,6 | 17,4 | 17,4 | 17,4 | 14,8 | 14,6 | 14,6 | 14,6 |
| - PDI (g/kg) | 122 | 126 | 126 | 126 | 97 | 99 | 99 | 99 |
| PDI (g):UNC | 140 | 140 | 140 | 140 | 97 | 97 | 97 | 97 |
| Price: - RON/Kg (2010) | 1,07 | 1,13 | 1,13 | 1,10 | 1,08 | 1,15 | 1,15 | 1,12 |
| - % | 100,00 | 105,6 | 105,6 | 102,8 | 100,0 | 106,5 | 106,5 | 103,7 |

**C** - the basic diet without fat supplementing; **SO** – the diet was supplemented with sunflower oil; **RO** – diet was supplemented with rapeseed oil; **GR** – diet was supplemented with grease.

Feeding lambs in the 4 experimental groups was made *ad libitum* with izoproteic TMR, differentiated for growth phase (90 days) and finishing (20 days). TMR were made of: chopped alfalfa hay, corn, triticale, barley and soybean oil cakes, providing 0.90 UNC / Kg and about 125 g PDI / kg in the growth phase and 1.0 UNC / kg and about 99 g IDP / kg in the finishing phase. Ratio PDI (g): UNC of food remained similar in all four groups, being 140 g PDI / UNC in the growth phase and 97g PDI / UNC in the finishing phase. It results that the only difference between the four TMR used for lambs feeding in the 4 groups is given by the experimental factor, respectively by the presence and fat supplement type used (vegetable fat: sunflower oil, rapeseed oil or animal fat: grease).

In the experimental period, the major bioproductive indices were registered phasial (weight gain, consumption of food and leverage). To assess the economic efficiency of the use of protected fat supplements in feeding lambs subjected to intensive fattening there were set the feed costs necessary to achieve a kg weight gain.

In the end of the experimental period there were made control slaughters, using every eight individuals/group to determine the main indices for slaughter, carcass quality and meat. Indices for slaughter and butchering carcasses by classes were done according to Pascal C. (2007).

Tissue structure of the carcas was made manually for each anatomical part and the results are presented as an average for each class of meat quality. All dates of productive effect and laboratory results were statistically processed and interpreted using the "t" test, the statistical model being composed of: control vs. fat, type of fat (vegetable fat vs. animal fat) and SO vs. RO.

**RESULTS AND DISCUTIONS**

Dietary supplementation of intensive fattening lamb with different types of protected fat influenced the weight gain, consumption of food and degree of recovery (Table 2).

*Table 2*

Effect of different bypass fat sources used in food, on the bioproductive performance of lambs

| | UM | Diets | | | | Significance | | |
|---|---|---|---|---|---|---|---|---|
| | | C | SO | RO | GR | 1 | 2 | 3 |
| Body mass | | | | | | | | |
| - initial | Kg | 15,48±0,61 | 15,57±0,32 | 15,71±0,43 | 15,60±0,29 | NS | NS | NS |
| - growth (90 days) | Kg | 34,51±0,86 | 37,76±0,78 | 36,63±0,81 | 35,55±0,77 | * | * | * |
| - finishing (30 days) | Kg | 38,12±0,95 | 41,57±0,80 | 40,50±0,78 | 39,36±0,82 | * | * | * |
| Total growth | Kg | 22,64 | 26,00 | 24,79 | 23,76 | - | - | - |
| Average daily growth | g | 211,49±9,83 | 246,55±8,42 | 232,92±9,18 | 221,69±10,2 | * | * | * |
| - growth phase | g | 180,37±10,72 | 190,54±7,42 | 191,59±6,81 | 190,70±9,46 | * | NS | NS |
| - phase of finishing | g | 205,83±8,49 | 236,36±8,75 | 225,41±7,23 | 216,05±10,5 | * | * | * |
| - average (110 days) | | | | | | | | |
| Daily consumption (110 days) | | | | | | | | |
| - feed | Kg | 1,643 | 1,609 | 1,612 | 1,603 | | | |
| - UNC | - | 1,528 | 1,544 | 1,547 | 1,539 | | | |
| - PDI | g | 187,30 | 176,99 | 177,32 | 176,33 | **1** - Control vs. Fat;<br>**2** - Type of fat (SO and RO vs. GR); **3** - SO vs RO<br><br>NS – p > 0,05<br>* - p < 0,05 | | |
| Specific consumption (110 days) | Kg | 7,982 | 6,807 | 7,152 | 7,421 | | | |
| - feed | % | 100,00 | 85,28 | 89,60 | 92,97 | | | |
| | - | 7,423 | 6,534 | 6,866 | 7,124 | | | |
| - UNC | g | 909,95 | 748,77 | 786,72 | 816,31 | | | |
| - PDI | Kg | 5,747 | 4,901 | 5,150 | 5,343 | | | |
| - Concentrate | Kg | 2,235 | 1,906 | 2,002 | 2,087 | | | |
| - Alfalfa hay | | | | | | | | |
| RON/KG gain | RON | 8,556 | 7,705 | 8,096 | 8,177 | | | |
| | % | 100,00 | 90,05 | 94,62 | 95,57 | | | |

**C** - the basic diet without fat supplementing; **SO** – the diet was supplemented with sunflower oil; **RO** – diet was supplemented with rapeseed oil; **GR** – diet was supplemented with grease.

Compared with lambs in the control group (C) fed with basic ration without fat supplementation, those who were fed different sources of protected fats have registered a higher speed of growth and a better degree of food recovery. Incorporating fat in the diet tended to reduce average daily feed consumption, probably due to higher energy value of the TMR and the effect they have on rumen microecosystem, reducing the intensity of browning fermentation processes (Vasta et. Al., 2006). Among the tested protected fat sources, the best results, respectively the best weight gain with the best food leverage, were provided by vegetable fats and especially sunflower oil. Relative to the entire experimental period (110 days) compared to lambs in the control group (C), supplementing food with protected fat (4% by weight) provided a plus to the total weight increase of 3.36 kg in SO group (with sunflower oil), of 2.15 kg in group RO (rapeseed oil) and of 1.12 kg in group GR (grease). The results we obtained are in agreement with those obtained by Ward et Abou. al., 2008, but in research, using tallow, grease and cotton oil, we obtained weight differences higher than the control group, probably because of high genetic potential of the lambs, which came from breeds specialized in meat production. Similar results were raported by Plascencia et. al. (1999). However, Clary et. al., (1993) and Abou Ward et. al. (2008) stated that 4% tallov tended to increase average daily growth. On contrast, El-Bedawy et. al. (1996) and Bolte et. al. (2002) revealed that, supplemental fat did not affect average daily gain.

The introduction of protected fat in the diet increased the price - RON / kg TMR values ranging from 2.8 to 5.6% in the growth phase and 3.7 - 6.5% in the finishing phase (Table 1). However, due to the positive effects it has had the fat supplement of feed on weight and degree of recovery of food, feed costs accruing to 1 kg weight gain, decreased by 4.43 - 9.95% compared to the control group.

These results were confirmed by the findings of Boer et. al. (1991) on sheep fed 3.5% tallow or soybean oil soap stock; Hutchison et. al. (2006) on steers fed diets containing 4% tallow or 4% grease and Brandt et. al. (1992) with steers supplemented with yellow grease and Moustafa et. al. (1995) on palm oil, who referred the improved feed efficiency to the significant intensification of energy of fat diets.

Intensive lamb fattening dietary supplementation with protected fats led to a significant increase in slaughter yield, especially when using vegetable fats (SO and RO) (Table 3).

*Table 3*

Effect of diet on slaughterhouse indices and carcass characteristics in Tzigai lambs

| | Diets | | | | Significance | | |
|---|---|---|---|---|---|---|---|
| | C | SO | RO | GR | 1 | 2 | 3 |
| The average weight at slaughter (kg) | 38,05 | 42,00 | 40,83 | 39,67 | * | * | * |
| Hot carcass weight (kg) | 17,52 | 20,41 | 19,75 | 18,57 | * | * | * |
| Cold carcass weight (kg) | 17,03 | 20,00 | 19,22 | 18,09 | * | * | * |
| Carcass yield (%) | 44,76 | 47,62 | 47,07 | 45,54 | * | ** | * |
| Non-carcass weight (kg)[a] | 12,23 | 13,96 | 13,84 | 13,09 | * | NS | NS |
| Subcutaneaus fat (mm) | 2,45 | 2,90 | 2,89 | 2,72 | NS | NS | NS |
| Eye muscle area ($cm^2$) | | | | | | | |
| - 5-6 intercostal space | 7,281 | 7,787 | 7,752 | 7,60 | * | NS | NS |
| - 12-13 intercostale space | 14,15 | 14,736 | 14,723 | 14,51 | * | NS | NS |
| The weight of body/chassis parts: | | | | | | | |
| - gigat chop % | 33,50 | 32,95 | 33,46 | 33,41 | NS | NS | NS |
| - chump % | 18,38 | 18,42 | 18,46 | 18,69 | NS | NS | NS |
| - class II - %[b] | 33,73 | 34,05 | 34,00 | 33,57 | NS | NS | NS |
| - class III - %[c] | 14,39 | 14,58 | 14,08 | 14,60 | NS | NS | NS |

**C** - the basic diet without fat supplementing; **SO** – the diet was supplemented with sunflower oil; **RO** – diet was supplemented with rapeseed oil; **GR** – diet was supplemented with grease. **a.** The „ non – carcass” fraction included the skin, feet, head, interval organs, mesenteric fat and empty gastro-intestinal tract of the lambs. **b.** The „class II” included: shoulders, arm, chest, ribs, **c.** The „class III” included: neck, meatloaf, tail.

**1** - Control vs. Fat; **2** - Type of fat (SO and RO vs. GR); **3** - SO vs RO; NS – $p > 0,05$, * - $p < 0,05$

Similar effects were found in the surface of the eye muscles, as measured by planimetry of 5-6 and 12-13 intercostal spaces, in agreement with the recommendations of Pop et al. (2008). The slaughter yield and eye muscle area values are lower than those cited in the literature (Ward et Abou. Al., 2008; Bolte et. Al., 2002; Ramdane et. Al, 2010) because the Tzigai breed on witch our researches have been carried out is not an improved breed for meat production, beeng considered a local race with relatively low production potential.

Protected fat from lambs feeding did not significantly affect the quality of carcasses, respectively the proportion of the slaughtering areas or the cut back fat thickness, the results are in agreement with those obtained by Mansoor et al. (2006), who supplemented lambs food with palm oil as such or in the form of calcium soap.

Increasing the energy value of food supplementation with different types of protected fat had a negative influence on the proportion of meat from the carcass. Thus the share of meat in the carcass tissue structure, also of the slaughtered areas dropped in favor of fat in groups SO, RO and GR compared with group C, while the share bones decreased so that the ratio meat (meat+fat)/bones was positively influenced by protected fat supplementation of food, following hierarchy being established the: C<GR<EN<SO (Table 4). The lowest ratio musculature: tallow was recorded in sample GR<C<EN<SO; both the carcass and cut regions, divided by class quality.

Tissue structure of the carcass is closely linked to the chemical composition of meat determined in the *longissimus dorsi* muscle and *bicep femoris*. Introduction of different types of protected fat in feed for intensive fattening lambs led to decreasing the proportion of meat and, respectively meat, protein levels (Nx6, 25) in favor of adipose tissue and fat (ether extract) of meat, which has attracted, normally, the increase in DM content of meat. Protected vegetable fat had a stronger influence, established the following hierarchy regarding the content of muscles and protein in the carcass: C> GR> SO> RO.

*Table 4*

Effect of diet on the structure and chemical composition of carcass tissue

| | | Diets | | | | Semnificația | | |
|---|---|---|---|---|---|---|---|---|
| | | C | SO | RO | GR | 1 | 2 | 3 |
| Tisular structure of the carcass (%) | Meat | 58,01 | 56,73 | 56,48 | 57,31 | * | * | NS |
| | Tallow | 22,76 | 24,91 | 25,10 | 24,01 | * | * | NS |
| | Bones | 19,23 | 18,36 | 18,42 | 18,63 | * | NS | NS |
| Tisular structure of 1st quality class meat (%)[a] | Meat | 60,00 | 58,81 | 58,10 | 58,73 | * | NS | NS |
| | Tallow | 20,09 | 22,40 | 22,66 | 21,64 | * | * | NS |
| | Bones | 19,91 | 18,79 | 19,24 | 19,63 | NS | NS | NS |
| Tisular structure of 2nd quality class meat (%)[b] | Meat | 59,15 | 56,79 | 57,07 | 58,42 | ** | * | NS |
| | Tallow | 19,80 | 23,07 | 22,83 | 21,04 | ** | * | NS |
| | Bones | 21,05 | 20,14 | 20,10 | 20,54 | * | NS | NS |
| Tisular structure of 3rd quality class meat (%)[c] | Meat | 55,70 | 54,61 | 54,36 | 54,97 | * | NS | NS |
| | Tallow | 27,90 | 30,29 | 30,52 | 29,40 | ** | * | NS |
| | Bones | 16,40 | 15,10 | 15,12 | 15,63 | * | NS | NS |
| Meat:bone ratio | Carcass | 4,20/1 | 4,45/1 | 4,43/1 | 4,35/1 | * | NS | NS |
| | 1st quality | 4,02/1 | 4,32/1 | 4,20/1 | 4,09/1 | * | NS | NS |
| | 2nd quality | 3,75/1 | 3,96/1 | 3,97/1 | 3,87/1 | * | NS | NS |
| | 3rd quality | 5,10/1 | 5,62/1 | 5,61/1 | 5,49/1 | * | NS | NS |
| Muscle:tallow ratio | Carcass | 3,02/1 | 3,08/1 | 3,07/1 | 2,39/1 | NS | * | NS |
| | 1st quality | 2,99/1 | 3,12/1 | 3,02/1 | 2,72/1 | NS | * | NS |
| | 2nd quality | 2,99/1 | 2,82/1 | 2,84/1 | 2,78/1 | NS | NS | NS |
| | 3rd quality | 2,00/1 | 3,61/1 | 3,60/1 | 1,87/1 | * | ** | NS |
| Gross chemical composition of m. longissimus dorsi (% of DM) | DM | 24,65 | 26,21 | 27,06 | 26,81 | ** | NS | NS |
| | Gross protein | 77,08 | 70,14 | 70,95 | 72,16 | ** | * | NS |
| | Ether extract | 19,96 | 23,05 | 22,28 | 22,17 | * | NS | NS |
| | SEN (glicogen) | 1,17 | 1,09 | 1,37 | 1,38 | NS | NS | NS |
| | Ash | 4,79 | 5,72 | 5,40 | 4,29 | NS | NS | NS |
| Gross chemical composition of m. biceps femoris (% of DM) | DM | 25,29 | 26,91 | 26,70 | 26,07 | * | NS | NS |
| | Gross protein | 77,41 | 73,47 | 73,74 | 76,87 | ** | * | NS |
| | Ether extract | 16,10 | 19,54 | 19,89 | 17,53 | ** | * | NS |
| | SEN (glicopen) | 1,31 | 1,83 | 1,61 | 1,38 | NS | NS | NS |
| | Ash | 5,18 | 5,16 | 4,76 | 4,22 | NS | NS | NS |

**C** - the basic diet without fat supplementing; **SO** – the diet was supplemented with sunflower oil; **RO** – diet was supplemented with rapeseed oil; **GR** – diet was supplemented with grease. **a.** 1st quality class– thigh + cutlet; **b.** 2nd quality class – : shoulders, arm, chest, ribs; **c.**. 3rd quality class – neck, meatloaf, tail.
**1** - Control vs. Fat; **2** - Type of fat (SO and RO vs. GR); **3** - SO vs RO; NS – p > 0,05, * - p < 0,05

**CONCLUSIONS**

Intensive lamb fattening dietary supplementation with different types of protected fat (SO - sunflower oil, RO - rapeseed oil and GR - grease) led to an increase in weight and degree of recovery of the food. Compared with the control group (C) total weight gain achieved throughout the experimental period was higher by 1.12 kg/head in sample GR, by 2.15 kg in RO group and 3.36 kg at SO group, while the leverage of food has improved by 7.03%, 10.4% and, respectively, 14.72%.

Protected fats in food have significantly improved efficiency at slaughter and eye muscle area determined by planimetry, but did not affect the cut portions of the carcass and the dorsal fat thickness.

Tissue structure of the carcass is linked to the chemical composition of meat determined in *longissimus dorsi* and *bicep femoris*. Introduction of different types of protected fat in feed for intensive fattening lambs led to decreasing the proportion of meat and, respectively meat, protein levels

(Nx6,25) in favor of adipose tissue and fat (ether extract) of meat, which has attracted, normally, the increase in DM content of meat. Protected vegetable fat had a stronger influence, established the following hierarchy regarding the content of muscles and protein in the carcass: C> GR> SO> RO.

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