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# EFFECT OF KIDS FEEDING WITH LINSEED CAKE: PRODUCTIVE PERFORMANCES AND SOME MEAT QUALITY TRAITS

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## Introduction

The cultivation of the linseed, particularly suitable in the Southern Italy areas, can be revalued thanks to a high content in linolenic acid (actually about 58%) considered the precursor of the essential ω3 fatty acids. For this reason, the nutritionists particularly recommend the use of this oil to satisfy the human nutritional requirements. Being an oil with such a high level of unsaturation, therefore susceptible to rapid oxidation, the cold-extraction is considered a good kind of production, since it ensures lipid stability. The linseed cake, residual by-product from this extraction system, is an animal feed particularly appetizing and very rich of refreshing quality proteins, as well as mainly provided of high quality lipids. Then it can be employed in animal feeding as an alternative protein source to the GMO (genetically modified organism) soy, really cultivated in the world in a quantity of around 63%, so guaranteeing an GMO free meat product for the consumer as well as good health and performance of the animal.

Previous studies on the use of linseed meal performed on growing cattle report results comparable to the ones of the soybean meal on the liveweight gains and on the carcasses composition (Berge *et al*., 1993) or even superior in the inclusion of fat in the carcasses (Dumont *et al*., 1997) when the protein level furnished from linseed meal increases. Omega-3 fatty acids are in part transferable to the ruminants fat (Scollan *et al*., 2001; Raes *et al*., 2002; Raes *et al*., 2004; Demirel *et al*., 2004) and develop an action in the prevention of the vascular deseases, showing an anti-thrombogenic and anti-atherogenic effect (de Lorgeril *et al*., 2001; Demirel *et al*., 2004; Ragni *et al*., 2004), as an effect of prevention in the colon cancer (Roynette *et al*., 2004). Many authors, besides, have used the linseed meal in the feeding for ruminants, especially cattle, since positive responses are obtained on the digestibility (Khorasani *et al*., 1994; Dixon *et al*., 2003a; Dixon *et al*., 2003b), on the performances (Dixon *et al*., 2003a; *et al*., 2003b; Raes *et al*., 2004), on the meat quality (Berge *et al*., 1993; Raes *et al*., 2002; Scollan *et al*., 2001; Raes *et al*., 2004) and on the fatty acid content (Wood *et al*., 2004). There are few information about the use of the linseed cake for the kids.

## Objectives

The present study aimed to investigate productive performance and some of the most important meat quality traits such as colour and tenderness, the chemical composition and fatty acid profile in kids fed on a linseed cake in comparison with a traditional diet based on soybean meal.

## Methodology

In order to evaluate the effect of linseed cake as a feed for kids on some quanti-qualitative characteristics, meat colour and tenderness, chemical and fatty acid composition, 16 male Garganica kids, weaned at 40±3 days of age, homogeneous for age and body weight, were used. After a week of adaptation to the pellet feeding, the kids were divided into two groups of 8 subjects each, and fed *ad libitum* for 6 weeks on either a concentrate pelleted diet containing soybean meal s.e. (Control group) or on a diet containing 20% linseed cake (LC group). Diets were planned so as to contain approximately the same amount of protein and crude fibre. Each animal was placed in a single box with respect to the animal welfare.

During the trial, the daily feed intake of each subject was detected, while the liveweight was monitored weekly in order to establish the daily weight gain and the feed conversion index.

The pH values were measured on the *Longissimus lumborum* (*Ll*) and *Semimembranosus* (*Sm*) muscles at slaughtering ($pH_1$) and after the carcasses were refrigerated for 24 hours at 4°C ($pH_2$). From each right half carcass the Lumbar region and Pelvic limb were separated and then dissected into their tissue composition: lean, fat and bone. The colorimetric indexes were assessed on the *Ll* and *Sm* muscles, once isolated from the respective cuts, using the Hunter Lab system (Colourmeter Miniscan XE, D65). From each muscle, half an inch of diameter samples were taken and subjected to the shear force according to the Warner Bratzler Shear device system by an Instron 5544 instrument. Besides, to determine cooking loss percentage, from each *Ll* muscle, meat samples homogeneous for dimensions (about 5 cm thick) were obtained, weighed before and after cooking in an electric ventilated oven at 165°C, until the internal temperature of 75 °C was reached in the core of the meat sample (ASPA, 1996), recorded by a thermocouple (Hanna Instruments). Then from cooked *Ll*, 1×1 cm section pieces were subjected to the cutting force. Moreover, chemical analysis and fatty acid profile were performed only on raw meat from *Ll* muscle. Lipids were extracted according to the 2:1 chloroform-methanol method described by Folch *et al.* (1957), whereas the acidic profile was assessed using a Chromopack CP 9000 gas chromatograph. Then the thrombogenicity index was also calculated (Ulbricht and Southgate, 1991). The data were analysed for the variance using the procedure GLM of SAS (1999). Means were compared by the “t” test of Student.

## Results & Discussion

From the results reported in Table 1, any significant difference between the two diets didn't emerge, although the kids of the Control group presented final live weights (20.97

*vs* 19.87 kg) and weight gains (0.152 *vs* 0.140 kg/d) slightly higher. Moreover, the kids fed on linseed cake evidenced a lower and significant (P<0.01) feed intake (0.642 *vs* 0.765 kg/d) and a better transformation of the feed, since its feed conversion index value was 4.71 against 5.15 kg/kg of the Control group subjects. The net cold dressing percentage (after 24 h at 4°C) was not influenced by the linseed cake integration in the diet (52.18 *vs* 51.10%).

The pH values of the *Sm* and *Ll* muscles (Table 2) at slaughtering didn't show differences between the two diets, while when measured on the m. *Longissimus lumborum*, after the carcasses refrigeration for 24 h at 4°C, they resulted significantly lower (P<0.05) in the LC group (5.75) than in the Control one (6.01).

On the dissecting the Pelvic limb (Table 3), no relevant difference was found in the lean and fat fractions, while the bone incidence resulted higher (P<0.05) in the LC (30.70%) than in the Control (28.75%). As regards the Lumbar region, the use of linseed cake would have not determined any difference in the bone and fat percentages, though both higher, and a lower incidence of lean (P<0.05). The cooking loss percentage (Table 4) resulted higher (P<0.01) in the m. *Ll* meats of the LC group in comparison with the Control one (17.98 *vs* 13.30%). As for the colour, differences didn't appear on the m. *Ll* in agreement with the considered parameters, while the m. *Sm* meats from the subjects fed on linseed cake resulted redder and yellower.

With regards to the shear force, differences were observed only on the m. *Ll* raw meats in the LC diet, even if they disappeared after cooking, whereas they were never noticed on the raw m. *Sm*. The employment of the linseed cake influenced the meat chemical composition by providing a product with reduced moisture content (P<0.01) as well as richer in fat in comparison with the control group (Table 5). As regards the fatty acid profile, the lipids of the meat from the kids fed on the linseed by-product showed a higher percentage of C14:0 (P<0.01) and a lower presence of C16:0 (P<0.05) and of C18:0 (P<0.01) than the control ones (Table 6). The data concerning the fatty acids as a whole allowed us to affirm that the linseed cake positively influenced the fatty acid profile of the meat, improving the unsaturated fraction (61.65 *vs* 55.90%; P<0.01), and particularly the monounsaturated one (53.15 *vs* 47.67%; P<0.01). The use of the linseed cake in the diet affected the PUFA classes amount, result interesting under a dietetic point of view: in fact, it was observed a lower content (P<0.05) of ω6 fatty acids (6.52 *vs* 7.15%) and a higher one (P<0.01) of ω3 fatty acids (1.97 *vs* 1.07%) in comparison with the control.

Meat from the kids fed on LC showed a better (P<0.01) thrombogenicity index (0.95 *vs* 1.34) and a ω6/ω3 ratio (3.39 *vs* 7.09) than the control one, with positive effects on human health (Galli, 1999), since the ω6/ω3 ratio value recommended by the Human Nutrition Society is equal to 4 (Carnovale and Marletta, 1997).

## Conclusions

Based on the results of this test, it may be deduced that the integration of the linseed cake allowed to get weight gains and final weights comparable to the ones of kids traditionally fed on soybean meal. In general, the latter provided some meat physical characteristics better than the linseed by-product. As regards the dietetic properties of the meat, the linseed cake produced a positive effect on the fatty acid profile, improving the

thrombogenic index and the ω-3 fatty acids content, with good consequences on human health.

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## Tables and Figures

Table 1 - Productive perfomances

| | Control | LC | SED |
|---|---|---|---|
| Samples (n.) | 8 | 8 | DF = 14 |
| Initial weights (kg) | 13.50 | 13.05 | 1.706 |
| Final weights (kg) | 20.97 | 19.87 | 1.992 |
| Weight gain (kg/d) | 0.152 | 0.140 | 0.026 |
| Feed intake (kg/d) | 0.765A | 0.642B | 0.078 |
| FCI (kg/kg) | 5.15 | 4.71 | 0.935 |
| Net cold dressing percentage (%) | 51.10 | 52.18 | 1.387 |

A, B: P<0.01

Table 2 - Measurements of pH on *Ll* and *Sm* muscles

| | Diet | | SED |
|---|---|---|---|
| | Control | LC | DF = 14 |
| *Ll*: $pH_1$ | 6.61 | 6.65 | 0.149 |
| $pH_2$ | 6.01a | 5.75b | 0.219 |
| *Sm*: $pH_1$ | 6.34 | 6.37 | 0.132 |
| $pH_2$ | 5.88 | 5.77 | 0.301 |

a, b: P<0.05

Table 3 - Dissecting data

| | Diet | | SED |
|---|---|---|---|
| | Control | LC | |
| | % on Pelvic limb weight | | DF = 14 |
| Pelvic limb weight (kg) | 1.27 | 1.23 | 0.164 |
| Lean | 63.97 | 61.97 | 2.202 |
| Fat | 7.27 | 7.32 | 1.431 |
| Bone | 28.75b | 30.70a | 1.503 |
| | % on Lumbar region weight | | |
| Lumbar region weight (kg) | 0.31 | 0.30 | 0.054 |
| Lean | 49.04a | 44.36b | 4.343 |
| Fat | 19.83 | 22.90 | 3.533 |
| Bone | 31.12 | 32.73 | 2.176 |

a, b: P<0.05

Table 4 - Meat quality traits

| | Diet | | SED |
|---|---|---|---|
| | Control | LC | |
| | *Longissimus lumborum* | | DF = 14 |
| Cooking loss (%) | 13.30B | 17.98A | 1.938 |
| L | 43.36 | 42.33 | 2.077 |
| a | 7.59 | 7.61 | 0.696 |
| b | 8.44 | 8.76 | 0.799 |
| Shear force - raw ($kg/cm^2$) | 7.07B | 8.49A | 0.639 |
| Shear force -cooked ($kg/cm^2$) | 3.62 | 3.57 | 0.589 |
| | *Semimembranosus* | | |
| L | 42.65 | 41.44 | 2.760 |
| a | 7.73B | 9.94A | 1.303 |
| b | 7.40b | 9.13a | 1.346 |
| Shear force - raw ($kg/cm^2$) | 6.40 | 5.30 | 1.363 |

A, B: P<0.01; a, b: P<0.05

Table 5 - Chemical composition of *Longissimus lumborum* muscle (% on raw meat)

| | Diet | | SED |
|---|---|---|---|
| | Control | LC | |
| Samples (n.) | 8 | 8 | DF = 14 |
| Moisture | 75.44A | 74.53B | 0.291 |
| Protein | 18.97 | 19.12 | 0.361 |
| Fat | 3.29B | 4.37A | 0.279 |
| Ash | 1.08 | 1.02 | 0.081 |
| Undeterminated | 1.21 | 0.96 | 0.300 |

A, B: P<0.01

Table 6 - Fatty acid profile (%) and T.I. in *Longissimus lumborum* muscle

| | Diet | | SED |
|---|---|---|---|
| | Control | LC | |
| Samples (n.) | 8 | 8 | DF = 14 |
| $C_{12:0}$ | 0.17 | 0.25 | 0.073 |
| $C_{14:0}$ | 2.30B | 3.15A | 0.419 |
| $C_{16:0}$ | 21.55a | 20.10b | 1.058 |
| $C_{18:0}$ | 16.95A | 10.72B | 0.384 |
| Saturated | 44.10A | 38.35B | 1.126 |
| Monounsaturated | 47.67B | 53.15A | 1.348 |
| Polyunsaturated | 8.22 | 8.50 | 0.635 |
| Unsaturated | 55.90B | 61.65A | 0.126 |
| ω6 | 7.15a | 6.52b | 0.555 |
| ω3 | 1.07B | 1.97A | 0.291 |
| ω6/ω3 | 7.09A | 3.39B | 1.664 |
| Thrombogenicity index | 1.34A | 0.95B | 0.056 |

A, B: $P<0.01$; a, b: $P<0.05$