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CAROB GERM BY-PRODUCT AS AN ALTERNATIVE PROTEIN SOURCE IN LAMB: EFFECT ON GROWTH PERFORMANCE AND MEAT QUALITY

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I. INTRODUCTION

Soybean meal is the most common protein source in intensive livestock production systems [1]. The production of soybean is associated with adverse environmental impacts, including deforestation, greenhouse gases emissions, fossil fuel exhaustion, land degradation, and eutrophication [2] [3]. Consequently, there is a strong case because the livestock sector should prioritize the replacement of conventional protein sources in animal feeding with alternative local protein sources [4]. The carob tree (*Ceratonia siliqua* L.) is a typical leguminous evergreen plant, widespread in the Mediterranean region. The carob pod is the fruit of the carob tree, which consists of two major parts: approximately 90% pulp and 10% seeds [5]. Among carob by-products generated during agri-food transformation, the carob germ flour is produced during the decortication and calibrated grinding of seeds, which is notable for its high protein content (over 50%) [6] [7] and elevated antioxidant capacity [8]. The aim of the present study was to investigate the effect of the total or partial replacement of soybean meal and maize with carob germ flour by-products in lamb diet. To this purpose, two different percentages of carob germ flour were tested, assessing their impact on animal performance and limited (or some) traits, and fatty acid (FA) composition of muscle lipid fractions.

II. MATERIALS AND METHODS

Thirty male lambs crossbred Valle del Belice × Pinzirita (initial body weight 12.7 ± 2.09 kg) at the age of 60 days were selected in a local dairy farm. Animals were transported to the university's experimental, assigned to three experimental groups and housed individually in separate pens. The first group was fed a conventional diet for fattening lambs (CON), including maize (430 g/kg DM), hay (300 g/kg DM), soybean meal (220 g/kg DM), molasses (30 g/kg DM), and vitamin-mineral (20 g/kg DM). While the second and the third groups received the same diet but with 250 g/kg DM of carob germ as partial soybean meal and maize replacement (C25) or 500 g/kg DM as a total replacement of soybean meal and partial of maize (C50), respectively. After 56 days, lambs were sacrificed in a local slaughterhouse, and carcasses were weighed, stored at 4°C for 24h, then reweighed. After that *longissimus thoracis et lumborum* muscle was collected, vacuum-packed and stored at -80°C until analyses. Feed samples were analyzed for fiber fractions, crude protein, fat, ash, total phenols, tannins, vitamins, and fatty acid composition using standard methods. Intramuscular lipids were extracted according to Folch et al. [9] with modifications, then separated into neutral and polar lipids. Lipid fractions were transesterified following Raes et al. [10] using sodium methoxide and acid chloride, and then separated in gas-chromatograph. To test the effect of the dietary treatment, all data were analyzed using one-way ANOVA. Each lamb was considered as experimental unit.

III. RESULTS AND DISCUSSION

The effects of dietary treatment on animal performance, some carcass and meat traits are presented in Table 1. The diet did not exert a negative effect on DM intake, average daily gain, final body weight and feed conversion ratio ($P > 0.05$). In addition, no significant differences were observed in the hot and cold carcass weight, pH and chilling loss ($P > 0.05$). These are key indicators when evaluating a new plant protein source in ruminant diets. This finding suggested that carob germ flour may be a suitable alternative local protein source, as a substitute for soybean.
Regarding intramuscular fatty acid profile, the content of total, polar and neutral fatty acids were not affected by dietary treatments ($P > 0.05$). Although the C25 and C50 groups ingested greater quantities ($P < 0.001$) of oleic (+153%; +122%), alpha-linolenic (+146%; +72%) and linoleic acids (+161%; +66%), the experimental diets did not influence the proportions of these fatty acids in meat, probably because mono- and poly-unsaturated FA are largely subjected to the biohydrogenation processes in the rumen.

Table 1 – Effect of carob germ meal on lambs intake and performance.

	Experimental diet[1]			SEM[2]	p-value
	CON	C25	C50		
DMI[3], g/d	868	955	930	32.7	0.555
ADG[4], g/d	231	240	251	10.1	0.727
Final body weight, kg	25.7	26.2	27.1	0.728	0.732
FCR[5]	3.82	3.99	3.76	0.088	0.600
Hot carcass weight, kg	11.4	11.6	12.1	0.357	0.692
Cold carcass weight, kg	11.2	11.4	11.9	0.354	0.674
Chilling loss, %	1.81	1.70	1.49	0.144	0.661
Meat pH after 24h	5.83	5.88	5.87	0.029	0.749
IMF, mg/g DM	58.76	63.58	70.76	2.913	0.268

[1]Treatments were concentrate diet (control) and concentrate + 25% carob germ flour (CAR 25%) and concentrate + 50% carob germ flour (CAR 50%); [2]SEM = Standard error of the mean; [3]DMI = dry matter intake; [4]ADG = average daily gain; [5]FCR = feed conversion ratio;

IV. CONCLUSION

Our results demonstrated that the inclusion of 25% and 50% of carob germ as a partial or total replacement of soybean meal and maize in the diet of growing lambs had no detrimental effects on animal growth, final body and carcass weight, and meat FA profile. Further studies need to be conducted in order to investigate all the other meat quality traits.
These findings suggest that feeding lambs with carob germ could be an effective strategy to reduce the feed-food competition, negative environmental impacts, including deforestation, greenhouse gas emissions, fossil fuel depletion, soil degradation, and eutrophication.

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