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The effect of replacing soybean meal with Fava bean seeds in daily ration of Lebanese Baladi goat kids and Awassi sheep lambs: 1- Body performance

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Abstract— *The aim of the study was to investigate the partial and complete substitution of imported soybean meal (SBM) with Fava bean seeds (FBS) in Awassi male lambs (S) and local Baladi goat kids (G) rations and the consequences on body performance. Fifteen growing lambs and 15 growing kids, with an initial bodyweight of 23.09 and 14.90 kg with 100 days of age, respectively, were fed cotton-seed meal (CSM), wheat bran and corn-based diet supplemented with protein legume sources, 75% FBS :25% SBM (S75 & G75), 0% FBS :100% SBM (S100 and G100-positive control) and 100% FBS :0% SBM (SC0 & GC0- negative control). Awassi lambs of all groups had comparable average feed intake (FI) accumulating between 43.9 and 49.4 kg/head and live body weight gain (LBWG) between 6.5 and 10.9 kg/head. Whereas local Baladi goat kids attained a cumulative LBWG levels of 5.7 and 3.96 kg/head and cumulative FI of 28.2 and 29.7 kg/head. Feed conversion ratio (FCR) for lambs attained the best results in group S50 (3.92) and the least in S100 (6.82) and for kids 7.14 in G100 and 5.25 in G75 groups. Feeding group S50 with 50% FBS and 50% SBM in based-ration gave more profit 17.2% than all other groups in comparison with SC0. On the other hand, G75 gave the highest profit by 19.15% in goat kids. Most notably, omitting soybean meal with or without additional protein legume as fava bean seeds replacements resulted in comparable high-body performance level.*

Keywords— ***Soybean meal, fava bean seeds, Awassi lambs, goat kids, feasability.***

I. INTRODUCTION

The need for alternative protein sources to soybean meal (SBM) in domestic animal feeding has recently gained focus. The main reasons include the attempt to limit SBM import from extra-EU Countries, which represents a negative voice of the commercial balance; an effort to decrease costs of animal production and contemporarily reduce the loss of N-compounds in the environment and the search to prevent the presence of GMO (Genetically modified foods) in the food chain (Wilkins and Jones, 2000; Mordenti and De Castro, 2005; Formigoni *et al.*, 2007). Among the possible protein sources, lupins, peas and fava beans *(Vicia fava L.)* were successfully used in ruminants and nonruminants (Burel *et al.*, 2000; Bonomi, 2005; Moschini *et al.*, 2005; Masoero *et al.*, 2006; Vandoni *et al.*, 2007; Keller *et al.*, 2021). Demand for pulses for stock feed both locally and in export markets is likely to have a major influence on prices. Pulses are valuable stock feeds because of their high protein levels and palatability (Henchion *et al.*, 2017). They can be used as part of intensive livestock rations or as supplements for stall reared stock. In some countries lupines are generally the preferred pulse for sheep and cattle because of their higher protein, higher fiber and lower starch levels, but peas and fava beans (FBS) are also useful and are commonly used overseas (Zagorakis *et al.*, 2018a). Pulses

are used in intensive rations to provide energy and essential amino acids for growth (Beigh *et al.*, 2017; Poutanen, 2022).

Small ruminant's production contributes to the livelihoods of a large number of farmers and accounts for 28-58 % of agricultural output in the Middle East (Iniguez, 2005). In Lebanon small farmers in marginal lands, where milk constitute an important source of income (Hosri and El khoury, 2004; De Rancourt *et al*., 2006; Hosri, *et al*., 2016), mainly conduct it. Awassi lamb-fattening and goat-fattening systems in Middle Eastern countries are popular because they can rapidly generate income. Nevertheless, feed costs constraining these systems and seasonal fluctuations in feed prices expose farmers to risk. Despite the important relative size of the small ruminant's flock in Lebanon (330000 head of sheep and 450000 head of goats (FAO, 2010), the sector is facing many difficulties.

The outbreak of BSE in the 1990s caused proteins of animal product to be banned as feed, but now it will be permitted for non-ruminants (Minchin, 2021). A large integrated Project called "Grain Legumes" is combining the efforts of scientists from 18 countries in order to make legume crops more competitive for European agriculture, using the latest progress in genomics and ranging from plant improvement and crop management to feed processing. Existing protein sources are primarily hindered by their negative environmental impacts with some concerns around health. However, they offer social and economic benefits, and have a high level of consumer acceptance (Henchion *et al.*, 2017; Małecki *et al.*, 2021)

Duc (1997), Haciseferogullari *et al.* (2003), Hossain and Mortuza (2006), Crepon *et al.* (2010); Yah Konfor (2013) and Mayer Labba *et al.* (2021) published that the nutritional value of fava bean has always been traditionally attributed to its high Protein content, which ranges from 27 to 34% depending on genotypes, Oil, 1.2 g; Crude Fiber, 5.1 g; Starch, 51 %; Sugars, 5 %; Iron, 4.2 mg; Thiamin, 0.45 mg; Riboflavin, 0.19 mg; Niacin, 2.4 mg; Energy, 328 kcal. Most of these proteins comprise of globulins (79%), albumins (7%) and glutelins (6%). In addition, Berrazaga *et al.* (2019) found that the nutritional value of fava bean was 87 and 31% for DM and CP, respectively. Legume seeds contain several comparatively minor proteins including trypsin inhibitors, lectins, lipoxygenase and urease, which are relevant to the nutritional quality of the seed (Bartsch and Valentine, 1986; Halmemies-Beauchet-Filleau, 2018).

Hanbury *et al*. (2000), Yin *et al.* (2011), Watson *et al* (2017), Yaacoub and Al Jammal (2018), Yaacoub *et al*. (2018), Halmemies-Beauchet-Filleau (2018), Lestingi *et al.* (2019), Ibáñez *et al*. (2020) and Parisi *et al.* (2020) reported that, to reduce reliance on imported soybean meal (SBM) in temperate environments, fava bean might be alternative protein sources for small ruminant diets. Surra *et al.* (1992), El Maadoudi (2004), Delmotte and Rampanelli (2006) noted that Fava bean is highly palatable for lambs, which prefer it to barley. In lambs, including fava beans up to 50% in the diet did not affect meat quality when compared to soybean meal Antongiovanni *et al.* (2002), Lanza *et al.* (2007) and Emiola and Gous (2011). Mullan (2001), FAO (2002), Connell and Hafi (2003), Mukherjee *et al.* (2016), Sedláková *et al.* (2016), Addisu (2016), Shi *et al.* (2017), Naumann *et al.* (2017), Choi *et al.* (2019), Samtiya *et al.* (2020), Te Pas *et al.* (2021), Mazumder *et al.* (2021), Mayer Labba *et al.* (2021) and Landi *et al.* (2021) stated that bean, chickpeas and lupine cultivars grown in most countries of the World tend to have now low tannin, vicine and covicine in their seed coats. Cerioli *et al.* (1998) and Shi *et al.* (2017) concluded that the bean has a lower content of trypsin inhibitors than the soybean and no urease activity but contains more tannins. Aplocina and Veipa (2015) reported that fava beans could be used in dairy rations at inclusion levels of up to 35%.

To our knowledge, the present study is among the firsts to focus on the effect of feeding FBS (fava beans) on body performance in Lebanese local *"Baladi"* goat and Awassi sheep breeds in fattening production. Therefore, data on the effect of FBS on body performance of fattening and meat quality of locally reared small ruminants are scarce.

The aim of our experiment was to evaluate the influence and feasibility of replacing totally or partially soybean meal with fava beans in rations fed to weaned lambs and kids of local Awassi sheep and local goat breeds (*Baladi*) on health and some traits of body performance.

II. METHODOLOGY

This experiment was divided into 2 trials: Trial I was conducted at "*Jarrah sheep farm*" at West Bekaa/Lebanon 5 Km of Zahleh (Bekaa district), 75 km from Beirut/Lebanon during May-June 2015. Relative humidity (RH %) and environmental temperature (T°C) that were recorded during this period of the year ranged between 50.3 - 76.9 and 26.6 - 24.6, respectively. Fifteen weaned Awassi male lambs weighing 23.33 ± 0.52 kg started a fattening experiment at the age of 100-120 days. The lambs were born with an average birth weight (BWT) of 4.23 ± 0.73 kg. Trial II was conducted during May-June months- 2015 for eight consecutive weeks on weaned male kids of local "*Baladi*" goat kids in Bziza at "*Ghattas animal farm*" in North-Lebanon (North district) 100 km

from Beirut. Relative humidity (RH %) and environmental temperature (TºC) that were recorded during this period of the year ranged between 57.6 – 79.1 and 28.5 - 25.1, respectively. Fifteen Kids with 13-14 weeks of age were fattened having an average live body weight (LBW) and at the beginning of the experiment (data collection) of 14.90 ± 0.259 Kg.

At the beginning of the trial and with the initiation of the preparatory period, (2 weeks) animals were dipped and treated for all kinds of helmentic worms. Besides, they were ear tagged and vaccinated against Anthrax and FMD; Albendazole was administered with drinking water as prevention for digestive tract parasites. Veterinary inspection was repeated every week where intramuscular injections of multivitamin dozes (A, D & E) were administered. The animals were in good health (veterinary examination).

All experimental animals (Trials I & II) were distributed randomly into five groups by 3 animals each under typical ecological and management conditions of environment (humidity and temperature) and fed five experimental rations as shown in Table 1. A combination (1:1) of good quality wheat straw and green hay was fed *ad libitum*; clean fresh water and mineral blocks (lickers) were available all the time inside the animal pens (2 x 2 m^2/group). Each animal-group was fed daily free choice forage feeds and around one and a half kg of the experimental mix-rations in feeding troughs and fresh water. All rations were isocaloric (2.9 Kcal/kg ME) and adjusted to the same level of crude protein (17%) as recommended by NRC (1989) and based on cotton seed meal (CSM), wheat bran and corn, fed continuously with different levels of Soybean meal (SBM) : Dry milled Fava bean seeds (FBS) for the whole experimental period.

Animals were assigned to the following five experimental rations (See table 1): The basal ration was adjusted to the recommended requiremnts of crude protein and energy by adding different levels (%) of cotton seed meal (CSM), wheat bran, corn and supplemented with different combination of soybean meal (SBM): fava bean seeds coarsely milled (FBS).

- Experimental groups - S25 (Sheep) & G25 (Goat) where FBS partially replaceing 25% of the SBM is added to the basal ration (25% FBS: 75% SBM).
- Experimental groups - S50 (Sheep) & G50 (Goat) where FBS partially replacing 50% of the SBM is added to the basal ration (50% FBS: 50% SBM).
- Experimental groups - S75 (Sheep) & G75 (Goat) where FBS partially replacing 75% of the SBM is added to the basal ration (75% FBS: 25% SBM).
- Experimental groups - S100 (Sheep) & G100 (Goat) where FBS totally replacing 100% of the SBM is added to the basal ration (100% FBS: 0% SBM).
- Experimental control groups - SC0 (Sheep) & GC0 (Goat) where this control ration was composed of 100 % SBM and no inclusion of FBS supplementing the basal ration (0% FBS: 100% SBM). In addition, this ration represents commercial feeding in fattening lambs and kids used at the Lebanese farms following the indoor keeping system.

Roughages (commercial wheat straw and green hay) were fed free choice. Experimental concentrate mixtures were fed starting with half kg/head daily (average) and adjusting the amounts given as the animals progressed in growing (in calculation to 3% of live body weight). Since it was very difficult to construct animal pens with individual feeding boxes, it was agreed to have group- feeding (3 lambs and 3 kids in each group with one common feeding trough). In order to know properly the amount of concentrate mix to be fed daily to each group during the whole week, it was allowed to adjust the amount once per week in the morning after each weighing by multiplying the 3% of the highest live body weight in each group by 3 (animals) and by 7 (days) and then at feeding time one of seven equal proportions was distributed in each animal group for seven consecutive days of the week. Half of the daily concentrate-mixn was offered in the morning and the other half in the late afternoon.

It was very significant to have knowledge of the cost price of the different ingredients used in the daily rations to figure out any profit in using them. Table 1 shows the actual prices in $USD paid ($/ton) for purchasing the ingredients during April-May months of the 2015 year prices at the Lebanese market and the calculations per ton of the rations prepared ($/Ton).

Table 1. Experimental concentrate-rations composition (% as fed basis) fed to lambs and kids

Cost price of Ingredients ($/ton)	Ingredients	S25/G25 75% SBM+ 25%FBS	S50/G50 50% SBM+ 50%FBS	S75/G75 25% SBM+ 75%FBS	S100/G100 100% FBS	SC0/GC0 (Control) 100% SBM
600	SBM	11.1	7.4	3.7	0.0	14.8
325	CSM	7.4	10.0	13.0	15.8	5.1
350	FBS	3.7	7.4	11.1	14.8	0.0
150	Wheat bran	16.0	15.0	12.7	12.3	14.7
250	corn	61.7	60.1	59.4	57.1	65.4
	Total	100.0	100.0	100.0	100.0	100.0
	CP	17.9	18.0	17.9	17.9	18.0
	ME Mcal/kg	2.85	2.52	2.94	2.28	2.96
	Cost price of rations ($/ton)	282	276	271	264	291

Refused feeds (what was left behind in the feeding troughs) from each pen if existeded were collected, weighed and recorded each week in the morning before the start of group-feeding. The trial proceeded for 8 weeks (collection of samples for analyses) after a preparatory period of 2 weeks to become adapted and acclimatized with the new experimental conditions.

Measurement of samples and calculation of Variables.

- Before initiation of the experiment, all concentrate-rations under investigation were chemically analyzed (percentage) for (AOAC, 1995): Dry matter (DM) content of the ration and each ingredient used; crude protein (CP); ether extract (EE); crude fiber (CF); ash.
- Health problems were inspected daily for indigestion and possible malnutrition and levels of mortality (if exist).
- Live body weights of each animal were recorded using typical balances: At the beginning of the preparatory period; at the initiation of the experiment; at the beginning of each week; at slaughter.
- The weekly cumulative feed intake in each group (wcFI/group) which is the total feed intake during the completely experimental period (8 weeks) was calculated by accumulating the weekly feed (wFI) intakes for each group.
- Weekly live body weight (wLBW) of each animal was measured at the start, end and during the experimental period on weekly basis (in the morning before feeding).
- Cumulative live body weight gain (cLBWG) was calculated by accumulating weekly LBW for the whole period or by subtracting the initial weight at the beginning of trial (W_0) from the final weight (W_f).
- Feed conversion ratio (FCR) at the end of the trial in each group was achieved by dividing total feed intake for the 8 weeks (FI) by total LBWG for the whole period.

Feasibility study and profitability calculations

Feasibility calculation of using the ingredients in concentrate mix rations containing SBM with/without FBS and meat profitability was achieved to show whether it is feasible and profitable using FBS, taking into consideration prices paid during May-June/2015 (Table 2).

Statistical analysis

Data were analyzed using the analysis of variance (ANOVA) procedure (Statistica, 2020). The experimental design was a randomized block design, with three replicates per treatment (3 x 5). Analysis of variance techniques were used to assess the statistical significance ($P<0.05$) of treatment effects. Feed intake (FI) and food conversion ratios (FCR) in each animal group were analyzed as apparent feed intake (aFI/head) and apparent feed conversion ratio (aFCR/head). Interaction and comparison among means was tested using the All Pair wise Multiple Comparison Procedures (Bonferroni test method) at a level of 5% significance. Mean ± SD (Mean values of the traits ± Standard Deviation) is used in all obtained statistical studies.

III. RESULTS AND DISCUSSION

Animal health and feed palatability

No health problems were noticed. The animals were in good health, no signs of indigestion or diarrhea or any blood signs in manure were observed. Moreover, the appetite as observed in all groups was acceptable where no left behind ration remaining was collected. The feed intake (FI) by all lambs and kids in all groups fed the different rations was 100 % palatable *(personal observations)*.

Experimental animals and feeding.

Random distribution of all lambs resulted in almost equal average weight among the five animal groups. The difference in the average initial Live Body weight (23.09 ± 0.52 kg) was statistically insignificant (P>0.05), where it ranged from the lowest as 22.8 ± 0.70 kg in group S100 and the highest as in S50 (23.70 ± 0.60 kg). Moreover, results obtained show that the difference in the initial kids live body weight (LBW) of all experimental animals (14.90 ± 0.259 Kg) were statistically non-significant (P>0.05) calibrating from 14.77 kg in GC0 (control group) to 15.03 kg as in group G25.

The results of the proximate chemical analysis analyzed on concentrate-ration samples before the initiation of the experiment, coincides with the proposed rations constructed where CP, EE, CF, Ash and calculated ME did not exceed 18%, 5.2%, 13%, 5.6% and 2.96 MCal/kg, respectively, as fed basis. Note that this was in agreement with the nutrient requirements of small ruminants as proposed by NRC (1989).

The amount of concentrate mix fed to lambs and kids for the whole period of the experiment did not exceed 49.35 and 30 kg/animal group respectively. In 1st week, the apparent daily feed intake (adFI) per animal in all groups averaged to 703 and 450g whereas, at the end of 8th week this value increased to 959 and 550g/head respectively, as 3% of live body weight recalculated as an average after weighing all the animals at the beginning of each proceeding week.

Measurement of samples and calculation of Variables.

Feed Intake (FI)

Data obtained show the weekly average variation in lambs (P<0.05) and kids FI (P>0.05) among groups from 1st week until the end of the experiment. The highest waFI for the 8 weeks was registered in group S50 (6.17 kg/head) vs G75 (4.3 kg/head) and the lowest in group S100 (6.17 kg/head) vs G100 (3.9 kg/head). This might be related to the fact that as Fava bean seeds (FBS) increases in the ration, FI decreases as in animal group G100 and the best was optimized in group G75 whose animals were consuming SBM on the level of 25 % of FBS in concentrate mix. Close to, this level was observed in animal group GC0 where FBS was not added (0 %). One explanation to this tendency is the complementary factor in both ingredients making them when mixed together more convenient for the goats to consume more and gain more making the diets more palatable.

The highest overall feed intake (FI) at the termination of the experiment was obtained (Fig. 1) in group S50 (49.35 kg) significantly higher (P<0.05) than S100 (43.94 kg) and S25 (45.94 kg) with a tendency to be higher (P>0.05) in groups S75 (47.34 kg) and SC0 (46.82 kg). In other words, animals of group S50 that consumed ration consisting of 50% FBS and 50% SBM was higher by 7.4%, 4.2%, 12% and 5.4% than that in S25, S75, S100 and SC0, respectively. In relation to kids G100 attained the least values by 28.2 kg and the highest in G75 (29.7 kg) at the end of the experiment (P>0.05). Once more this might be related to the fact that rations fed to animal-group G100 did not contain SBM and only 100 % FBS making the consumption of rations for goats lower than any other legume-ingredients combination. As SBM decreases and FBS increases in rations we observe an increase (P>0.05)) in feed intake as in G25 (28.7 kg), G50 (29.3 kg) and G75 (29.7 kg). Most properly that inclusion of big amounts of FBS in rations fed to goat kids has a positive effect on feed consumption relating this to the good flavor and taste and anti-nutritional factors contained in Fava bean.

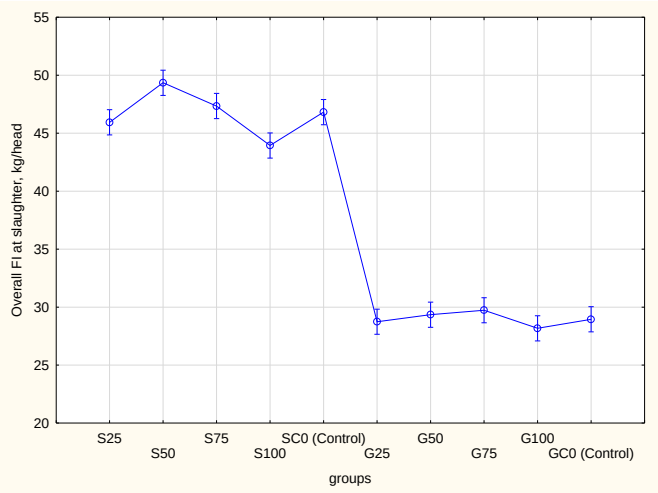

Fig.1. Overall feed Intake (FI, Kg/head)-Lambs Vs Kids

Live body weight (LBW).

Results (Fig. 2) observed at the end of eighth (end of the experiment) weeks showed a significant increase (P<0.05) in average animal weight of S50 group (4.59 Kg) where animals received 50% FBS and 50% SBM in comparison with S100 (29.22 Kg) where animals did not receive SBM in concentrate mix. Moreover, Group S50 recorded the

best body weight increase among all groups. This shows that feeding concentrate mix containing different combinations of SBM: FBS to lambs gives better results than feeding animals with mix containing SBM or FBS alone.

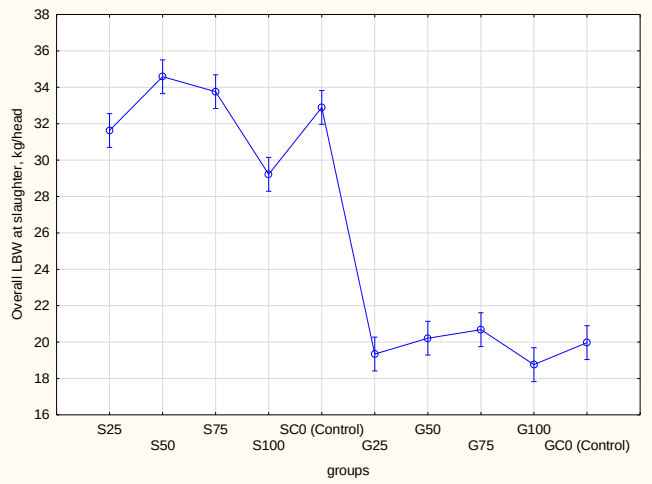

Fig.2. Live body weight at the end of the experiment, Kg/head- Lambs Vs Kids

It was very important to notice from figure 2 that as SBM decreases in combination with FBS higher weights were obtained as in group G75 vs G100 whose animals consumed daily rations without SBM addition.

Despite the fact that Live body weight of kids at the end of the experiment attained the highest level in animal group G75 (20.7 kg/head) but it did not show any significant differences with the remaining animal groups, G25, G50, G100 and GC0 attaining the average/animal 19.34 kg, 20.21, 18.76 and 19.97 kg, respectively (P>0.05). It seems that concentrate mix containing any combination of SBM to FBS has more palatability and at the same time more digestibility in animal digestive tract and consequently in all over nutrient metabolism of the body resulting in higher LBW values. This reflects the fact that neither antinutritional factors nor any toxins found in FBS influenced negatively the absorption of nutrients from the body gastro-intestinal tract from stimulating the animals to gain more weights. It is worthy to point out the fact that great (P<0.05) body weight (32.9 kg) was obtained in animal group SC0 than S100 (29.2 kg) but did not exceed the results (P>0.05) obtained in group S50 (34.6 kg) and S75 (33.8 kg).

Overall live body weight gain (LBWG).

Results show that the overall differences in the overall live body weight gain. Animals of group S50 (50% SBM: 50% FBS) kept in increasing in body weight (P<0.05) where they accumulated 5.8 kg/1st month *Vs* 4.1, 3.2 and 4.8 kg/1st month in groups S25, S100 and SC0, respectively followed by 5.2 kg/1st month in group S75 (P>0.05) . It seems that the best combination used in the experimental ration was in concentrates mix fed to group S50, where the highest results were obtained. This variable for group S50 continued to increase in the same pattern reaching the highest LBWG at the end of the 2nd month where the experiment was terminated attaining the level of 10.9 kg vs 8.5 and 6.5 kg in groups S25 and S100 (P<0.05), respectively and 10.8 and 9.9 kg in groups S75 and SC0 (P>0.05), respectively. As it is shown in Figure 3 animals of group G75 that were fed a ration containing 25% SBM and 75% FBS gained the highest weight (LBWG) at slaughter attaining the level of 5.68 kg in comparison with G100 (P<0.05), G25 (P>0.05), GC0 and G50 (P>0.05) by 3.96 kg, 4.31kg, 5.20 kg and 5.32 kg, respectively.

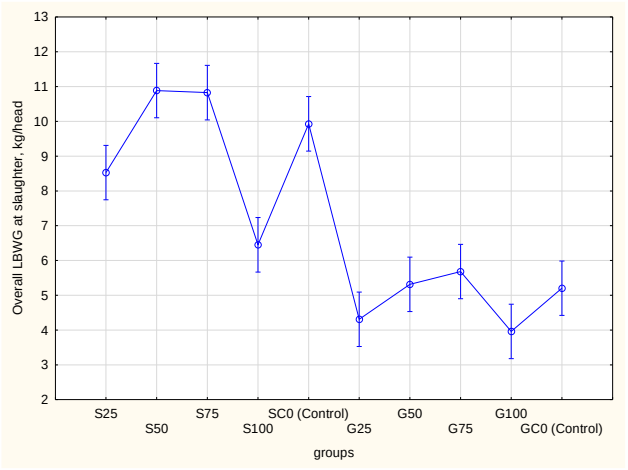

Fig. 3. Overall LBWG, kg/head- Lambs Vs kids

Feed conversion ratio (FCR)

The most negative results accumulated (P<0.05) at the end of the experiment, as shown in figure 4 was in S100 (6.82) in comparison with S25 (5.39) [P>0.05], SC0 (4.74) [P<0.05], S75 (4.39) [P<0.05] and the most efficient S50 (3.92) [P<0.05]. Note that this decrease in the efficiency of feed conversion to meat at the 8th week of the experiment was significantly (P<0.05) greater in group G100 (7.14) than G50, G75 (the most efficient) and SC0 attaining the levels of 5.54, 5.25 and 5.63 respectively. Moreover, results achieved at the end of the experiment in groups G25 (7.68) and G100 (7.13) were almost insignificantly the same (P>0.05).

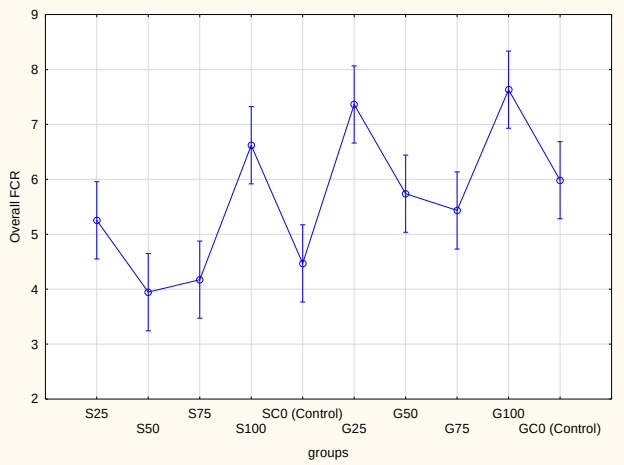

Fig. 4. Overall FCR – Lambs Vs Kids

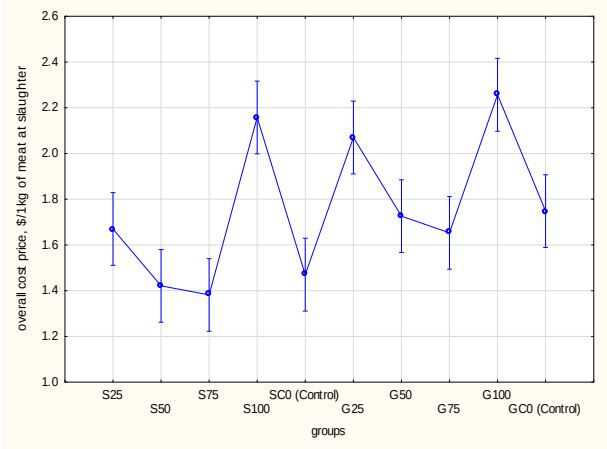

Fig. 5. Overall cost-price ($/1 kg of meat) - Lambs Vs kids

Once more it was shown that rations containing no SBM like in group G100 have negative effect on conversion of rations to meat by eating more feeds and gaining less weight. On the contrast treatment G75 and S50 whose animals were fed rations containing only 25% and 50% of SBM with 75% and 25% FBS has maximum positive effect on conversion of feeds to meat, respectively.

Feasibility study

The results obtained from figure 5 show that feeding FBS with combination with SBM as 50: 50 % as in groups S50 S75, G50 and G75 gave the best and higher results. Moreover feeding FBS (S100 and G100) as the sole legume ingredient did not succeed in giving more profit than other animal groups. Besides feeding rations containing 50 % FBS: 50 % SBM and 75 % FBS: 25 % SBM gave better profit than feeding with 25 % FBS: 75 % SBM. More over, fugure 5 shows the cost price ($) of 1 kg of mutton and goat meat. The most inexpensive meat was recorded for group S75 (1.38 $/1 kg mutton) followed by S50 (1.42), SC0 (1.47), S25 (1.67 $), respectively. The most expensive lamb meat was registered in S100. On the other hand, data obtained from the cost price of 1 kg of meat was higher concerning goat meat where the highest was noted in animal group G100 (2.26 $) followed by G25 (2.07 $). In the same context the lowest was achieved in G75, G50 and GC0 by 1.65 $, 1.73 and 1.75 $, respectively.

Feeding and Growth Performance

The choice of selecting Fava Beans as a replacement for SBM in our experiment agreed with the findings of many researchers as they proposed various species of home-grown grain legumes, such as pea, fava bean, and lupin that represent strategically important alternatives to soybean. They are widely available in Mediterranean areas and increase the sustainability of crop–livestock systems by safeguarding soil fertility and reducing greenhouse gas emissions and use of nitrogen fertilizer (Bonanno *et al.*, 2012; Calabrò *et al.*, 2015). Recently, Calabrò *et al.* (2015) noted in their studies that seed legumes have been regarded as alternatives to soybean as sources of protein in animal feeding owing to disputes about the use of genetically modified organisms (GMOs). In addition, Bonanno *et al.* (2012) considered that legume grains have attracted attention as alternative vegetable protein components for feedstuffs that are used in organic production of meat. The acceptability of fava bean seeds as partial or full replacement for soybean meal in fattening small animals (growing lams and kids) feeds was investigated in this study. Of interest was whether a significant trend in performance would be evident as a result of the changing proportions of soya and fava beans in the experimental feeds, and whether the animals would consume one of the rations excessively in preference to the other. The results suggest that the nutritional quality of the five rations for lambs as well as kids was sufficiently similar in all respects such that performance was the same on all experimental feeds, and neither of the rations was excessively consumed in preference to the other.

Metabolizable energy (ME) value calculated for all rations containing FBS and SBM was almost identical to the analyzed value (2.28-2.96 Mcal/kg). Moreover, the crude protein content of the lambs and kids rations

(~180g/kg) measured in Trials I and II was in good agreement with the values reported by Committee on Animal Nutrition (2007).

Good results were obtained from experiments on Awassi sheep and Sannen kids conducted by Negesse *et al.* (2001), Muruz *et al.* (2017), Burçak and Yalçın, (2018), Yaacoub and Aljammal (2018), Yaacoub *et al.* (2018), Ramos *et al.* (2019) and Yateem *et al.* (2021) in using the same levels of energy and protein in their experiments in comparison with the levels that were used in our trials. In the same context, Surra *et al.* (1992) conducted two experiments on weaned lambs feeding in rations lentils (Vicia ervilia) and faba (Vicia faba) beans were substituted (50% or 100%) for soybean cake in diets for weaned lambs. Substituting fava beans for soybean cake had no effect on performance of lambs.

Feed Intake

Lamb animals of group S50 that consumed ration consisting of 50% FBS and 50% SBM was higher by 7.4%, 4.2%, 12% and 5.4% than that in S25, S75, S100 and SC0, respectively. The highest cumulative feed intake (cFI) at the termination of the experiment was in group S50 (49.35 kg) significantly higher ($P<0.05$) than S100 (43.94 kg). As for kids the overall accumulation of feed intake for the whole period of the experiment was the highest in goat kids group G75 attaining the level of 29.7 kg at the end of the experiment ($P>0.05$). Whereas the daily average of FI for the complete period calibrated between 0.96 kg/head/day for Awassi lambs and 0.59 kg/head/day for Baladi goat kids.

Once more, this might be related to the fact that rations fed to animal-group G100 did not contain SBM and only 100 % FBS making the consumption of rations for goats lower than any other legume-ingredients combination. As SBM decreases and FBS increases in rations we observe an increase ($P>0.05$)) in feed intake. Most properly that inclusion of big amounts of FBS in rations fed to goat kids has a positive effect on feed consumption relating this to the good flavor and taste and anti-nutritional factors contained in Fava bean. Generally, the type of dietary legume supplementation has no effect on growth, animal health and feed palatability in both lambs and kids as well, where no health anomalies or malnutrition were noticed. Whereas no left behind concentrated mix was collected in all over the period of the two trials.

In the present experiment feed intake in both trials increased linearly with fava bean inclusion, suggesting that the animals needed to consume more of this ingredient to meet their nutrient requirements in energy and protein. Similarly, feed intake is unlikely to increase with fava bean content, as it did in our trials, if there is a toxin present in the fava beans. Giovanni (1984), Surra *et al.* (1992) and Massimiliano *et al.* (1999), observed the same increase in concentrates intake containing Fava bean. The latter suggested that the level and activity of anti-nutritive factors in Fava bean, mainly tannins, have less effect on ruminants than monogastric animals.

In reference, our achieved results coincides with the findings of Surra *et al.* (1992), Caballero *et al.*, 1992, El Maadoudi (2004), Delmotte and Rampanelli (2006) and Lanza *et al.* (1999, 2007, 2011) noting that fava bean is highly palatable for domastic small ruminants, which prefer it to barley. In growing lambs and fattening sheep and goats, including fava beans in isoprotein and isoenergetic diets in substitution for soybean meal did not affect intake, performance and digestibility. They also added that in lambs, including fava beans up to 50% in the diet did not affect meat quality when compared to soybean meal. The use of a diet based largely on fava bean for fattening lambs resulted in growth and meat characteristics similar to the most frequently used diets containing soybean meal as the main source of protein.

Nevertheless, all the results obtained from our research confirmed the findings of Kung *et al.* (1991), Murphy & McNiven (1994), Stanford *et al.* (1996), Vicenti *et al.* (2009), Facciolongo *et al.* (2014, 2015), Lestingi *et al.* (2015a, 2015b, 2016), Yaacoub and AlJammal (2018) and Yaacoub *et al.* (2018). In their earlier studies, they confirm the use of diets that incorporated fava bean, alone and in mixtures, as alternative protein sources to soybean in feeding for fattening lambs and kids that did not negatively affect the in vivo performances or carcass yield and quality. The absence of negative effects on intake, growth, and carcass quality, when replacing SBM with fava beans, support the results of previous studies with Simmental bulls fed a maize-silage based diet (Keller *et al.*, 2021) and Marchigiana bulls fed a diet with >550 g concentrate/kg total diet DM (Cutrignelli *et al.*, 2008a; 2008b).

Live body weight (LBW) and Live body weight gain (LBWG)

Overall, average weekly gain for lambs and kids (around 172 and 107 g/day/head, respectively) was substantially comparable with the one found in similar previous experiments (Caballero *et al.* 1992; Lanza *et al.* 2003b; Loe *et al.* 2004). In addition, carcass weights at the end of the trials were not affected by dietary treatments. The average values attained for lambs the levels of 32.4 and kids 19.8 kg/head) were higher compared to those (<17 kg) reported in previous similar experiments where these

differences can be probably attributed to different slaughter ages (Lanza *et al.*, 2007). More over, Loe *et al.* (2004) did not observe significant differences in carcass weights from lambs fed diets with different peas proportions as well as Surra *et al.* (1992) and Purroy *et al.* (1992) between lambs fed diets including different proportions of fava bean and those fed soybean meal-based diets. Carcass classification according to European regulations showed favorable acceptability by local markets with medium fat coverage and good or optimal muscular conformation. Diets with alternative legume seeds, such as peas and fava bean, did not adversely affect growth performance compared to soybean meal diet. Difference in the initial LBW between Awassi lambs and Baladi kid goats was related to the difference in species where, Baladi kids (14.9 ± 0.259 kg) were lower in LBW than Awassi lambs (23.1 ± 0.52 kg) of the same age. Despite this fact feed intake was significantly ($P<0.05$) correlated ($r =1$) to LBW taking into consideration the size of the animal. Distribution of all animals were equal ($P>0.05$) in live body weight in reference to the species used (Sheep and goats). In agreement, Cutrignelli *et al.* (2008a, 2008b) observed a lower live body weight (LBW) at an earlier fattening period for animals fed fava beans instead of SBM, possibly due to limited rumen undergraded protein (RUP) supply. However, in the present study, significant differences were found in growth performance at earlier growing periods and continued to the end of the trial especially in S100 and G100 (100% FBS) Vs S50 and G50 (50% FBS: 50% SBM) and S75 and G75 (75% FBS :25% SBM). This fact revealed that, fava beans in appropriate combination with SBM seem to be an applicable replacement for SBM in the diets of fattening sheep and goats. Even though S50 showed, an intensive decrease in weekly live body weight gain (waLBWG) from week one to week three, where it continued until week six, we noticed better absolute average live weights at the end of the experiment. No explanation was found to clarify this phenomenon; a combination of soybean meal and fava seed meal fed together with daily rations gives better results. Whereas feeding solely SBM or FBS result in lighter weights and minimum body weight gains.

Once more results show that a combination of soybean meal and fava seed meal fed together with daily rations gives better results. Whereas feeding solely SBM or FBS result in lighter weights and minimum body weight gain.

The cumulative live body weight gain (cLBWG) initiated with the end of the 1st week increased from week to week attaining the highest score after one week of the initiation of the experiment to increase ($P<0.05$) by 1.6 kg/week in group S50 *Vs* 0.9 kg/week, 1.2, 0.7 and 1.2 kg/week in groups S25, S75, S100 and SC0, respectively. Animals of group S50 (50% SBM: 50% FBS) kept in increasing in body weight ($P<0.05$) where they accumulated 5.8 kg/1st month *Vs* 4.1, 3.2 and 4.8 kg/1st month in groups S25, S100 and SC0, respectively followed by 5.2 kg/1st month in group S75 ($P>0.05$). It seems that the best combination used in the experimental ration was in concentrates mix fed to group S50, where the highest results were obtained. This variable for group S50 continued to increase in the same pattern reaching the highest cLBWG at the end of the 2nd month where the experiment was terminated attaining the level of 10.9 kg vs. 8.5 and 6.5 kg in groups S25 and S100, respectively and 10.8 and 9.9 kg in groups S75 and SC0 ($P>0.05$), respectively. Animals of group G75 that were fed a ration containing 25% SBM and 75% FBS gained the highest cumulative weight gain (cLBWG) at the end of the trial attaining the level of 5.68 kg in comparison with G100 and G25 ($P<0.05$), GC0 and G50 ($P>0.05$) by 3.96 kg, 4.31kg, 5.20 kg and 5.32 kg, respectively. The best results on weekly live body weight gain (wLBWG), were achieved in G75 and the least in G100 at the end of the termination of the trial ($P<0.05$).

Importantly, experimental concentrates applied in the present study were always completely consumed by the animals, indicating a high palatability of these concentrates independent of protein source. Loe *et al.* (2004) noted that diets with alternative legume seeds, such as peas and fava bean, did not adversely affect growth performance compared to soybean meal diet. Our results obtained were in contrast with the findings achieved by Caballero *et al.* (1992) who stated that the use of a lamb fattening diet largely based on fava bean gave similar growth performance and meat characteristics compared to the traditional diets based on soybean meal as main protein source.

Antongiovanni *et al.* (2002), Martinez *et al.* (2004) and Morbidini *et al.* (2005) obtained results similar to ours on young growing lambs fed fava bean seeds (50-60% of the diet) as the sole protein source in concentrate mix increased daily weight gain demonstrating the already high protein value of fava beans for growing lambs. Duke (1981) suggested the fact that to reduce reliance on imported soybean meal (SBM) in temperate environments, fava bean may be alternative protein sources for small ruminant diets. Fava bean is used as an important source of protein rich food in developing countries and as both food and feed for animals in industrialized countries. Edwards (2004) showed that, tannins present in the seed coat of fava beans have limited effect on broilers, pigs or ruminants. The trypsin inhibitor activity in fava beans is not well documented but appears to be low. In agreement to what

was proposed by Liener (1976), Dvořák *et al.* (2006) and Esenwah and Ikenebomeh (2008) that stated that the nutritional value of leguminous proteins might be limited by the presence of antinutritional factors. The protease inhibitors, trypsin and chymotrypsin, are perhaps the most widely distributed of all antinutritional factors in legumes. Monogastrics are thought to be more susceptible to the effects of antinutritional factors than ruminants. In fact, for ruminants, trypsin inhibitors are not considered important (McDonald *et al.*, 1973). In contrast to Cerioli *et al.* (1998) who concluded that, beans have a lower content of trypsin inhibitors than the soybean and can be used as proposed by Matthews and Marcellos (2003) in dairy rations at inclusion levels of up to 35%.

Feed conversion ratio (FCR)

The highest values (inefficient) in body retention of lambs per week (wFCR) were observed in animal group fed 100% FBS (S100) that calibrated between 60.3% at the end of the 1st and 40.3% by the end of the 8th week in comparison with results obtained in animal group fed 100 % SBM (SC0). This can be explained, by consuming more feeds to convert them to body weight gain and at the same time getting less live body weights due maybe to the overall effect of antinutritional factors found in fava bean seeds which was included as a sole legume ingredient (100% FBS) in ration. Moreover, results that are more efficient were achieved in groups S50 and S75 whose animals were fed a combination of SBM: FBS in different proportions. If to compare the overall average results among lamb groups for the whole period we observe that wFCR in group S75 (4.36) was less than what was obtained in groups SC0 (4.67), S50 (4.71), S25 (5.31) and S100 (6.89). Nevertheless, lambs of group S100 inefficiently converted feeds into body weight gain than animals of other groups. It was noticed that from the end of the 1st week wFCR in S100 was inefficiently ($P<0.05$) higher (6.71) than groups S50 (3.31), SC0 (4.17), S75 (4.01) and S25 (5.34) as well ($P>0.05$). This can be explained by the findings reported by Miller (1980) that fava bean protein is highly soluble in the rumen. Whereas, Emiola and Gous (2011) agreed that Fava bean feeding at various levels did not affect digestibility. However, Fulpagare (1993) reported that as the level of fava bean increase (from 25 to 100%) in the diet of lambs, the digestibility of dry matter (Ether extract and crude fiber) increase, while that of nitrogen-free extracts (NFE) decreases. The best results accumulated ($P<0.05$) at the end of the experiment for lambs was in S75 (4.39) followed by S100 (6.82), S25 (5.39), SC0 (4.74), and the most efficient was S50 (3.92).

Once more it was shown that rations containing no SBM like in group G100 have negative effect on conversion of rations to meat by consuming more feeds and gaining less weight. On the contrast treatment G75 whose animals were fed rations containing only 25% of SBM with 75%, FBS has maximum positive effect on conversion of feeds to meat. This can be explained by the findings reported by Miller (1980) that fava bean protein is highly soluble in the rumen. Whereas, Emiola and Gous (2011) agreed that Fava bean feeding at various levels did not affect digestibility. However, Fulpagare (1993) reported that as the level of fava bean increase (from 25 to 100%) in the diet of animals, the digestibility of dry matter (Ether extract and crude fiber) increase, while that of nitrogen-free extracts (NFE) decreases.

Although in the trial conducted by Brand *et al.* (1995) performance was not reduced when fava beans were included at 0.2 kg of the diet, which was in contrast with our findings. Nevertheless, Results obtained by Abbey *et al.*, 1979; Guillaume, 1977; Rubio *et al.*, 1990; Reddy *et al.*, 1985; Marquardt, 1989; Wiseman & Cole, 1988; Jansman *et al.*, 1995 and Knox *et al.*, 1995) were in agreement with our findings. Where performance has been reduced by the inclusion of fava beans this has been attributed to the content of condensed tannins and non-starch polysaccharides (NSP) in the seeds.

Thus, the development of untraditional protein crops may be a solution to improve the valorization of products and forage grown on the farm. Among alternative protein sources to soybean, lupine and pea seeds have been successfully used in diets for dairy cows in European and American countries (Murphy *et al.* 1987). In addition to these legumes, field beans (FB, *Vicia faba* L.) could represent another interesting alternative, as recently suggested by Volpelli *et al.* (2010) in a study with dairy cows fed organic diets.

IV. CONCLUSION

In summary, the 50: 50 and 75: 25 proportion of FBS: SBM improved bofy performancr profile compared to values reported for conventional fattening diets, without additional metabolizable protein-concentrate supplementation.

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REFERENCES

[1] Abbey, B.W., Neale, R.J. & Norton, G., 1979. Nutritional effects of field bean (Vicia faba) proteinase inhibitors fed to rats. Br. J. Nutr. 4:34-38.

[2] Antongiovanni, M., Acciaioli, A., Franci, O., Ponzetta, M. P., Pugliese, C., Buccioni, A., Badii, M., 2002. Field bean (*Vicia fava* var. *minor*) as a protein feed for growing lambs with and without protected lysine and methionine supplementation. Italian J. Anim. Sci., 1 (3): 229-238.

[3] AOAC, 1995. Official Methods of Analysis. 16th ed., AOAC, Washington, DC, USA.

[4] Aplocina, E. and Veipa, L., 2015. Including of Field Beans as Protein Source in Feed Ration for Dairy Goat. 7th International Conference on Chemical, Ecology and Environmental Sciences (ICCEES'2015) June 17-18, 2015 Pattaya (Thailand).

[5] Beigh Afzal Yasir, Abdul Majeed Ganai, Haidar Ali Ahmad, 2017. Prospects of complete feed system in ruminant feeding: A review. Vet World. 10(4): 424–437.

[6] Bonanno, A., Tornambè, G., Di Grigoli, A., Genna, V., Bellina, V., Di Miceli, G. & Dario Giambalvo, D., 2012. Effect of legume grains as a source of dietary protein on the quality of organic lamb meat. J. Sci. Food Agric. 92, 2870-2875.

[7] Bonomi, A., 2005. L'impiego dei semi di pisello espansi (Pisum sativum L.) nell'alimentazione dei suini produttori di carne da consumare fresca. Riv. Suinicolt. 46(4): 189-193.

[8] Burcak, Ender & Yalçin, Sakine. 2018. Effects of dietary sepiolite usage on performance, carcass characteristics, blood parameters and rumen fluid metabolites in Merino cross breed lambs. Applied Clay Science. 163. 10.1016/j.clay.2018.07.001.

[9] Burel, C., Boujard, T., Tulli, F., Kaushik, S.J., 2000. Digestibility of extruded peas, extruded lupin, and rapeseed meal in rain-bow trout (Oncorhynchus mykiss) and tur-bot (Psetta maxima). Aquaculture 188:285-298.

[10] Caballero, R., Rioperez, J., Fernandez, E., Marin, M.T., Fernandez, C., 1992. A note on the use of field beans (Vicia faba L.) in lamb finishing diet. J. Anim. Prod. 54 (3):441-444.

[11] Calabrò, S., Cutrignelli, M.I., Lo Presti, V., Tudisco, R., Chiofalo, V., Grossi, M., Infascelli, F. & Chiofalo, B., 2015. Characterization and effect of year of harvest on the nutritional properties of three varieties of white lupine (Lupinusalbus L.). J. Sci. Food Agric. Doi: 10.1002/jsfa.7049.

[12] Cerioli C, Fiorentini L, Prandini A, Piva G., 1998. Antinutritional factors and nutritive value of different cultivars of pea, chickpea and fava bean. In: Recent advances of research in antinutritional factors in legume seeds and rapeseed. Wageningen Pers, Wageningen (Netherlands). EAAP. Publ 93: 43-46.

[13] Yateem, C. A. M., Mustafa, K. N., & Alkass, J. E., 2021. Effect of different protein levels on growth performance, carcass trait, digestibility and some blood bieochemical parameters in awassi lambs. Iraqi Journal of Agricultural Sciences, 52(5), 1070–1076.

[14] Committee on Animal Nutrition, 2007. National Research Council. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids. 2007. The National Academies Press.

[15] Crepon K., Marget P., Peyronnet C., Benoit Carroue B., Arese P., Gerard Du., 2010. Nutritional value of fava bean (Vicia fava L.) seeds for feed and food Field Crops Research 115 (2010) 329–339.

[16] Cutrignelli, M. I., Calabrò, S., Bovera, F., Tudisco, R., D'Urso, S., Marchiello, M., & Infascelli, F. (2008b). Effects of two protein sources and energy level of diet on the performance of young Marchigiana bulls. 2. Meat quality. Italian Journal of Animal Science, 7(3): 271-285.

[17] Cutrignelli, M. I., Piccolo, G., Bovera, F., Calabrò, S., D'Urso, S., Tudisco, R., & Infascelli, F. (2008a). Effects of two protein sources and energy level of diet on the performance of young Marchigiana bulls. 1. Infra vitam performance and carcass quality. Italian Journal of Animal Science, 7(3): 259-270.

[18] De Rancourt M., Fois N., Lavin M.P., Tchakerian E. and Vallerand F., 2006. Mediterranean sheep and goats production: an uncertain future. Small Ruminat Res., 62, p. 167-179.

[19] Delmotte, C., P. Rampanelli, 2006. Whole or crushed fava bean with barley - mixed or fed separately - for feeding indoor reared grass weaned lambs Renc. Rech. Ruminants, 13: 77-80.

[20] Duc, G., 1997. Fava bean (*Vicia fava* L.). Field Crops Res., 53 (1-3): 99-109.

[21] Duke, J. A., 1981. Handbook of Legumes of World Economic Importance. Plenum Press, New York and London, 345 pages.

[22] Dvořák R, Pechová A, Pavlata L, Klejdus B, Kovarčík K, Dostálová J, Culková J, Filípek J, Švajdlenka E, Čapková V., 2006. Reduction in the content of antinutritional substances in fava beans (Vicia fava) by different treatments. Slov Vet Res 43 (Suppl.): 174-179.

[23] Edwards, A.C., 2004. Fava beans as stock feed – value and opportunities. Proceedings Bean Focus, 2004.

[24] El Maadoudi E.H., 2004. Lupine and horse-bean seeds in diets of growing and fattening sheep. In: Ben Salem H. (ed.), Nefzaoui A. (ed.), Morand-Fehr P. (ed.). *Nutrition and feeding strategies of sheep and goats under harsh climates*. Zaragoza : CIHEAM, 2004. p. 249-253. (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 59). 9. Seminar of the Sub-Network on Nutrition of the FAO-CIHEAM Inter-Regional Cooperative Research and Development Network on Sheep and Goats, 2001/11/08-10, Hammamet (Tunisia). http://om.ciheam.org/om/pdf/a59/04600037.pdf.

[25] Emiola, A., Gous, R., 2011. Nutritional evaluation of dehulled fava bean (Vicia fava cv. Fiord) in feeds for weaner pigs. South African Journal of Animal Science, 41 (2):79-86.

[26] Esenwah Christiana N. and Marcel J. Ikenebomeh, 2008. Processing Effects on the Nutritional and Anti-Nutritional

Contents of African Locust Bean (Parkia biglobosa Benth.) Seed. Pakistan Journal of Nutrition 7 (2): 214-217.

[27] Facciolongo, A.M., De Marzo, D., Ragni, M., Lestingi, A. & Toteda, F., 2015. Use of alternative protein sources for finishing lambs. 2. Effects on chemical and physical characteristics and fatty acid composition of meat. Prog. Nutr. 17(2): 165-173.

[28] Facciolongo, A.M., Rubino, G., Zarrilli, A., Vicenti, A., Ragni, M. & Toteda, F., 2014. Alternative protein sources in lamb feeding. 1. Effects on productive performances, carcass characteristics and energy and protein metabolism. Prog. Nutr., 16 (2): 105-115.

[29] FAO, 2010. FAOSTAT, FAO Statistics Division, Rome, Italy.

[30] Formigoni, A., Fustini, M., Mordenti, A.,Nocetti, M., Vecchia, P., 2007. Favino episello nella razione, buoni sostituti della soia. Inform. Agr. 63(17):40 - 44.

[31] Fulpagare, 1993. Nutritional Evaluation of Bakla (Vicia Fava L.) on Long Term Feeding in Lambs. (Thesis/dissertation, Manuscript).

[32] Guillaume, J., 1977. Use of field bean (Vicia fava L.) and peas (Pisum sativum) in laying hen and growing chicken diets, In: Protein Quality from Legume Crops. Ed. Commission of European Communities. Brussels. Luxembourg, (ECSC-EEC-CAEC). pp. 217-231.

[33] Haciseferogullari, H., Gezer, I., Bahtiyarca Y. and Menges H.O., 2003. Determination of some chemical and physical properties of Sakiz fava bean (*Vicia fava* L. *Var. major*). J. Food Eng., 60: 475-479.

[34] Henchion Maeve, Maria Hayes, Anne Maria Mullen, Mark Fenelon, Brijesh Tiwari, 2017. Future Protein Supply and Demand: Strategies and Factors Influencing a Sustainable Equilibrium. J. Foods. 6(7): 53. Published online 2017 Jul 20. doi: 10.3390/foods6070053.

[35] Hosri Ch., Tabet E. and Nehme M., 2016. Goat and sheep products value chain analysis in Lebanon.In: "The value chains of Mediterranean sheep and goat products. Organisation of the industry, marketing, strategies, feeding and production systems."Options Meditrraneennes. Series A: Mediterranean Seminars, 115, p.61-66. CIHEAM.

[36] Hosri Ch. and El Khoury N., 2004. Valoriser le fromage de chevre traditionnel « Darfiyeh » pour aider au developpement de la region montagnarde nord libanaise. Options Mediterraneennes, Serie A, 61, p. 201-206.

[37] Hossain, M.S. and Mortuza, M.G., 2006. Chemical composition of *Kalimatar*, a locally grown strain of fava bean (*Vicia fava* L.). Pak. J. Biol. Sci., 9: 1817-1822.

[38] Iniguez L., 2005. Characterization of small Ruminant Breeds in West Asia and North Africa (vol.1), ICARDA, Aleppo, Syria.

[39] Jansman, A.J.M., Verstegen, M.W.A., Huisman, J. & Van den Berg, J.W.O., 1995. Effects of hulls of fava beans (*Vicia fava* L.) with a low or high content of condensed tannins on the apparent ileal and fecal digestibility of nutrients and the excretion of endogenous protein in ileal digesta and feces of pigs. J. Anim. Sci. 73: 118-127.

[40] Keller, Magdalena, Beat Reidy, Andreas Scheurer, Lukas Eggerschwiler, Isabelle Morel, and Katrin Giller. 2021. "Soybean Meal Can Be Replaced by Faba Beans, Pumpkin Seed Cake, Spirulina or Be Completely Omitted in a Forage-Based Diet for Fattening Bulls to Achieve Comparable Performance, Carcass and Meat Quality" *Animals* 11 (6): 1588. https://doi.org/10.3390/ani11061588.

[41] Knox, A.I., McNeill, L. & McNab, J.M., 1995. Nutritional value of white-and coloured-flowering field beans (*Vicia fava* L.) for poultry. Br. Poult. Sci. 36: 850-851.

[42] Kung, L. Jr., Maciorowski, K., Powell, K.M., Weidner, S. & Eley, C.L., 1991. Lupin as a protein supplement for growing lambs. J. Anim. Sci. 69, 3398-3405.

[43] Landi, N., Piccolella, S., Ragucci, S., Faramarzi, S., Clemente, A., Papa, S., Pacifico, S., & Di Maro, A., 2021. Valle Agricola Chickpeas: Nutritional Profile and Metabolomics Traits of a Typical Landrace Legume from Southern Italy. J. Foods (Basel, Switzerland), 10(3), 583. https://doi.org/10.3390/foods10030583.

[44] Lanza M., Pennisi P., Priolo A., 1999. Fava bean as an alternative protein source in lamb diets: effects on growth and meat quality, Zootech. Nutr. Anim. 25: 71–79.

[45] Lanza, M., Bella, M., Priolo, A., Fasone, V., 2003b. Peas (Pisum sativum L.) as analternative protein source in lamb diets:growth performances, and carcass andmeat quality. Small Ruminant Res. 47:63-68.

[46] Lanza, M. Bella, M., Barbagallo, D., Fasone, V., Finocchiaro, L., Priolo, A., 2003a. Effect of partially or totally replacing soybean meal and maize by chickpeas (Cicer arietinum L.) in lamb diets: growth performances, carcass and meat quality. Anim. Res. 52: 263-270.

[47] Lanza, M., Bella, M., Priolo, A., Pennisi, P., 2007. Alternative legume seeds and lamb meat quality. Option Méditerranéennes, Serie A Séminaires Méditerranéennes 74:171-176.

[48] Lanza, M., Fabro, C., Scerra, M., Bella, M., Pagano, R., Brogna, D.M.R. & Pennisi, P., 2011. Lamb meat quality and intramuscular fatty acid composition as affected by concentrates including different legume seeds. Ital. J. Anim. Sci. 10:e18, 87-94.

[49] Lestingi, A., Facciolongo, A.M., Caputi Jambrenghi, A., Ragni, M. & Toteda F., 2016. The use of peas and sweet lupin seeds alone or in association for fattening lambs: Effects on performance, blood parameters and meat quality. Small Rum. Res. 143: 15-23.

[50] Lestingi, A., Facciolongo, A.M., De Marzo, D., Nicastro, F. & Toteda, F., 2015a. The use of faba bean and sweet lupin seeds in fattening lamb feed. 2. Effects on meat quality and fatty acid composition. Small Rum. Res. 131: 2-5.

[51] Lestingi, A., Toteda, F., Vicenti, A., De Marzo, D. & Facciolongo, A.M., 2015b. The use of faba bean and sweet lupin seeds alone or in combination for growing lambs. 1. Effects on growth performance, carcass traits, and blood parameters. Pak. J. Zool. 47(4): 989-996.

[52] Liener, I.E., 1976. Legume toxins in relation to protein digestibility a review. Journal of Food Science, 41: 1076-1081.

[53] Loe, E.R., Bauer, M.L., Lardy, G.P., Caton, J.S., Berg, P.T., 2004. Field pea (Pisum sativum) inclusion in corn-based lamb finishing diets. Small Ruminant Res. 53:39-45.

[54] Małecki Jan, Siemowit Muszyński, Bartosz G. Sołowiej, 2021. Proteins in Food Systems—Bionanomaterials, Conventional and Unconventional Sources, Functional Properties, and Development Opportunities. J. Polymers (Basel) 13(15): 2506. Published online 2021 Jul 29. doi: 10.3390/polym13152506.
Article PubReader PDF–2.0MCite.

[55] Marquardt, R.R., 1989. Dietary effects of tannins, vicine and convicine. In: Recent Advances of Research in Anti-nutritional Factors in Legume Seeds. Eds Huisman, J., Van der Poel, A.F.B. & Liener, I.E., Pudoc, Wageningen, The Netherlands. Pp.141-155.

[56] Martınez, T., Moyano, F., Dıaz, M., Barroso, F., Alarcon. F., 2004. Ruminal degradation of tannin-treated legume meals. Journal of the Science of Food and Agriculture, 84(14): 1979-1987.

[57] Masoero, F., Moschini, M., Fusconi, G., Piva, G., 2006. Raw, extruded and expanded pea (Pisum sativum) in dairy cows diets. Ital. J. Anim. Sci. 5:237-247.

[58] Matthews, P. and Marcellos, H. 2003. Faba Bean. Agfact P4.2.7., Second Edition 2003, Division of Plant Industries, New South Wales Agriculture, Australia, 1-12. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157729/faba-bean-pt1.pdf.

[59] Mayer Labba Inger-Cecilia, Hanne Frøkiær and Ann-Sofie Sandberge, 2021. Nutritional and antinutritional composition of fava bean (Vicia faba L., var. minor) cultivars. Food Research International, 140)110038), Pp. 11.

[60] McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., 1973. Animal Nutrition. 2nd edition. Oliver and Boyd, Edinburgh, p. 401.

[61] Miller, E. L., 1980. Protein value of feedstuffs for ruminants. Vicia fava: Feeding value, processing and viruses (ed. D. A. Bond), pp. 17.

[62] Minchin Joshua, 2021. EU lifts ban on feeding livestock processed animal protein (PAP) (New Food), https://www.newfoodmagazine.com/content_author/joshua-minchin-new-food/

[63] Morbidini, L, E. Rossetti, F. Cozza, M. Pauselli, 2005. Different protein source (soybean or fava bean) in postweaning diets for Apennine and Sopravissana (Italian Merino) light lamb: slaughtering performances Ital. J. Anim. Sci. Vol. 4 (Suppl. 2): 360-362.

[64] Mordenti A, De Castro P., 2005. Mangimi gm e produzioni tipiche, una convivenza forzata. Informatore Agrario 14:47-50.

[65] Moschini, M., Masoero, F., Prandini, A., Fusconi, G., Morlacchini, M., Piva G., 2005. Raw Pea (Pisum sativum), raw Fava bean (Vicia fava var. minor) and raw Lupin (Lupinus albus var. multitalia) as alternative protein sources in broiler diets. Ital. J. Anim. Sci. 4:59-69.

[66] Murphy, M., P. Udén, Don L Palmquist, H Wiktorsson, 1987. Rumen and Total Diet Digestibilities in Lactating Cows Fed Diets Containing Full-Fat Rapeseed. Journal of Dairy Science. 70(8):1572-82.

[67] Murphy, S.R. & McNiven, M.A., 1994. Raw and roasted lupin supplementation of grass silage diets for beef steers. Anim. Feed Sci. Technol. 46: 23-35.

[68] Muruz H, Kaya İ, Çetinkaya N, Salman M, Atmaca E., 2017. The effects of diets with different protein contents on growth performance and digestibility, and on some ruminal fermentation and blood parameters, in Bafra lambs. Kafkas Univ Vet Fak Derg, 23 (6): 939-946, 2017. DOI: 10.9775/kvfd.2017.18007.

[69] NRC, 1989. Nutrient requirements of sheep.

[70] Poutanen Kaisa S, Anna O Kårlund, Carlos Gómez-Gallego, Daniel P Johansson, Nathalie M Scheers, Ingela M Marklinder, Anne K Eriksen, Pia C Silventoinen, Emilia Nordlund, Nesli Sozer, Kati J Hanhineva, Marjukka Kolehmainen, Rikard Landberg, Grains – a major source of sustainable protein for health, Nutrition Reviews, Volume 80, Issue 6, June 2022, Pages 1648–1663.

[71] Purroy, A., Surra, J., Munoz, F., Morago, E., 1992. Empleo de leguminosas grano en el el pienso para cebo de corderos: III. Guisantes (Use of seed crops in the fattening diets for lambs: III. Pea seeds). Producci´on Animal 88A: 63-69 (in Spanish).

[72] Ramos, Z., I. De Barbieri, E. van Lier, F. Montossi. 2019. Body and wool growth of lambs grazing on native pastures can be improved with energy and protein supplementation. Small Ruminant Research, Volume 171: 92-98.

[73] Negesse, M. Rodehutscord, E. Pfeffer, 2001. The effect of dietary crude protein level on intake, growth, protein retention and utilization of growing male Saanen kids. J. Small ruminant research, 39: 243-251.

[74] Reddy, N.R., Pierson, M.D., Sathe, S.K. & Salunkhe, D.K., 1985. Dry bean tannins: A review of nutritional implications. J. Am. Chem. Soc. 62: 541-549.

[75] Rubio, L.A., Brenes, A. & Castano, M., 1990. The utilization of raw and autoclaved fava bean (Vicia fava L. var. minor) and fava bean fractions in diets for growing broiler chickens. Br. J. Nutr. 63: 419-430.

[76] Shi, L., Mu, K., Arntfield, S. D., & Nickerson, M. T., 2017. Changes in levels of enzyme inhibitors during soaking and cooking for pulses available in Canada. Journal of food science and technology, 54(4):1014–1022. https://doi.org/10.1007/s13197-017-2519-6.

[77] Stanford, K., McAllister, T.A., Lees, B.M., Xu, Z.J. & Cheng, K.J., 1996. Comparison of sweet white lupin seed, canola meal and soybean meal as protein supplements for lambs. Can. J. Anim. Sci. 76: 215-219.

[78] Statistica 14, 2020. TIBCO Data Science.

[79] Surra, J., Purroy, A., Muñoz, F. and Treacher, T., 1992. Lentils and faba beans in lamb diets. J. Small Ruminant Research, *7*(1): 43-49.

[80] Vandoni, S.L., Vercelli, G., Borgo, G., Vitali, G., Gagliardi, R., Innocenti, M., Bassini, A., Sgoifo Rossi, C.A., 2007. Il pisello proteicocome fonte di fibra. L'Allevatore Magazine 63(20) :40-47.

[81] Vicenti, A., Toteda, F., Di Turi, L., Cocca, C., Perrucci, M., Melodia, L., Ragni, M., 2009. Use of sweet lupin (Lupinus albus L. var. Multitalia) in feeding for Podolian young bulls and influence on productive performances and meat quality traits. Meat Sci., 82(2): 247-251.

[82] Volpelli, L.A., Comellini, M., Masoero, F., Moschini, M., Lo Fiego, D.P., Scipioni, R., 2010. Fava beans (Vicia fava) in dairy cow diet: effect on milk production and quality. Ital. J. Anim. Sci. 9:138-144.

[83] Wilkins, R.J., and R. Jones, 2000. Alternative home-grown protein sources for ruminants in the United Kingdom. Anim. Feed Sci. Tech. 85:23-32.

[84] Wiseman, J. & Cole, D.J.A., 1988. European legumes in diets for non-ruminants. In: Recent Advances in Animal Nutrition. Eds Haresign, W. & Cole, D.J.A., Nottingham University Press. pp. 13-37.

[85] Yaacoub Rami, Zaprianka Shindarska, Boulos AlJammal. 2018. Effect Of Feeding Weaned Awassi Male Lambs With Faba Beans (Vicia Faba) As Compared To Soybean Meal On Body Performance. Jahorina, 04-07 October 2018, Bosnia and Herzegovina, AGROSYM Symposium Proceedings. 1712-1717.

[86] Yaacoub Rami, Boulos AlJammal, 2018. The Effect Of Feeding Weaned Local Male Kids Goats "Baladi Breed" With Faba Beans (Vicia Faba) As Compared To Soybean Meal On Body Performnace. Jahorina, 04-07 October 2018, Bosnia and Herzegovina, AGROSYM Symposium Proceedings. P: 1718-1723.

[87] Yah Konfor, P., 2013. Potential to replace part of the current meat consumption in Sweden with locally produced faba beans – Effects on land use and food system sustainability. Swedish University of Agricultural sciences. Faculty of landscape Planning, Horticulture and Agriculture Science. Master´s thesis in Agricultural Sciences. Pp. 51.

[88] Zagorakis K., Liamadis D., Milis Ch., Dotas V., Dotas D., 2018a. Effects of replacing soybean meal with alternative sources of protein on nutrient digestibility and energy value of sheep diets. South African Journal of Animal Science 48(3). DOI:10.4314/sajas.v48i3.9.