Weaning lambs of dairy breed at 20 days of age and cheap rearing with whole grain and pelleted protein concentrate (review)

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SUMMARY

The aim of the paper is to review Bulgarian and international experiments of easy weaning methods for lambs at 20 – 30 days of age, and developing appropriate and cheap starter feeding up to 25 kg live weight, which allows to achieve high daily gain. In Bulgaria ware tested two methods of early weaning of lambs of dairy breeds. 1) Lambs suckle their dams for 10 – 20 minutes at increasing intervals of 12, 24, 48, 72 h, then they are completely weaned. 2) Depriving lambs of approximately half of the milk for 5 – 6 days before weaning by separation for 12 h from their dams. There is no significant difference in stress at gradual weaning starting *ca*. 15 days after birth and complete weaning at about 20 – 25 days of age of the lamb with the two methods. The second method is preferable because of easy routine management. Live weight losses are avoided and check period is short (4-6 days). Pelleting of starter feed improved intake and daily live weight gain, compared with mash starters. Combining dried distiller's grain with solubles (DDGS) and soybean meal as a source of protein tends to give better gain, compared to DDGS plus sunflower meal (P=0,08) or DDGS and rape expeller. There are no significant differences between cereal grain of maze, wheat and barley as a source of energy in starter diets. The cheapest scheme of feeding under Bulgarian conditions is by pelleted protein concentrate (PPC) with 30% crude protein plus whole (not ground) cereal grain (maze, barley or wheat) in proportion approximately 1:1, for lambs with live weight up to 25 – 27 kg. Daily gain in live weight varied from 240 to 300 g in different experiments. It is possible to offer the two components of the diet mixed or separate. The preferable size of pellets is 4.2 mm diameter and 8 – 12 mm length for young lambs. When fattening continues it is necessary to increase the proportion of whole grain and to decrease PPC. Replacement lambs should follow traditional feeding/pasture scheme after 25 – 27 kg live weight. Early weaning allowed

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milking 30 – 45 kg more milk per ewe, fattening lambs to desired live weight or raising high quality replacement lambs. The applied scheme of weaning and raising lambs is easy and attractive for farmers. The cost of feed for 1 kg gain is 23% cheaper for systems with PPC+ whole grains, compared to commercial starter feeds.

Keywords**:** methods of weaning, lambs, pelleted protein concentrate, whole grain, milked milk, economics

INTRODUCTION

Traditional sheep production in the Balkan area is facing economic difficulties. It is necessary to take a lot of measures for quick improvement of the economic situation (Todorov, 2010). In dairy sheep production one of the main tools for improving economics is increasing the milk yield. Selection or in some case crossing with high milk yielding breed will eventually improve milk production, but the progress is slow. Nowadays in the Balkan area (except for a few farms keeping a special dairy breed) milked flocks predominate, milking beginning after weaning of lambs, usually at 45 - 75 days of age, and yield range between 40 to 100 kg milk per ewe. A possibility to increase the milked milk is the early weaning of lambs at 20 - 25 days' age and their feeding with starter feed, a well-proven practice. According to Bulgarian experiments additional milk yield is about 30 to 45 kg per ewe (Simeonov et al., 2010), and early weaning is profitable (Stoikova et al. 2009). McKusick et al. (2001) also find that it is possible to combine early lamb weaning and early milking of the ewes by fattening the lamb to the desirable live weight and good carcass quality. Another problem is the relatively high prices of starter feeds provided by the compound feed industry (Ivanova et al. 2010).

Early weaning of lambs is a relative term and includes weaning between 14 and 70 days of age. The aim of this paper is to review efficiency of some methods of early weaning of lambs before 30 days of age. The second objective is to find a cheap and easy scheme of feeding early weaned lambs for replacement or fattening.

METHODS OF EARLY WEANING

Magee (1978) concluded, on the basis of an experiment with 32 Suffolk-Finn sheep crossbred lambs, that lambs can be weaned successfully to dry diets at 10 days of age. Later, Pond et al. (1982) carried out four experiments to test different weaning methods to dry pig starter or dry lamb starter at 10 days of age. The main problem was rumen impaction because lambs do not drink enough water. The mortality was rather high. Body weight and daily gain at 6 weeks were similar for lambs reared conventionally on liquid-milk replacer

for 4 weeks and for those weaned at 10 days to dry pig starter. Authors concluded that insufficiencies in physical or physiological maturity of the gastrointestinal tract appear to be associated with higher mortality and, therefore, present a limitation to the practice of rearing 10 days old lambs on dry diets.

Lane et al. (1986) wean successfully lambs at 14 days of age. The growth check was 12.2 days and was not influenced by birth weight, sex or weaning weight. Function of rumen increased quickly after 16 days of age. Poe et al. (1971) reported that lambs receiving dry feed in creep established quickly microbial population by 10 to 14 days of age that is capable of digesting starch and cellulose.

Weaning lambs can be done successfully without serious retardation of growth at 21 days of age (Brown, 1965; Large, 1965; Walker and Hunt, 1981; Paliev, 1987) or below 11 kg live weight (Bozzolo et al. 1993), or when lambs have doubled their initial birth weight and consume a minimum of 200 g/d complementary dry food (Theriez, 1991). According to Glimp et al. (1965) when weaning at 30 – 45 days of age the period of growth check (no weight gain) lasted about 1 week.

Four experiments were carried out with two Bulgarian dairy breeds (Stara Zagora Local Sheep, and Black Head Pleven Sheep) with about 90 – 100 kg milk yield per ewe for milking period (Dimova et al. 2009). Lambs were receiving starter feed which was given to them during the experimental period, plus meadow or alfalfa hay, from 6 – 7 days' age in the creep. First method of preparing the lambs for weaning included from 15 – 18 days of age (variation in different experiments and animals) lambs were separated from their mother for 12 h and rejoined after milking ewes. Lambs were separated from ewes during daylight time to facilitate eating dry feed and drinking water in the creep. By deprivation of approximately half of the milk lambs are forced to increase intake of dry feed.

The second method for preparing the lamb for gradual weaning included shortening the period of suckling to 10 – 12 minutes after 15 – 18 days of age and increasing the interval of suckling at 12, 24, 36 and 48 h and complete weaning.

A comparison of the two mentioned methods of gradual weaning show equal efficiency, but reducing the suckling time to 12 h is easier from a practical point of view, compared to short suckling with increasing intervals. Live weight losses are avoided and check period is only 4 – 6 days (Simeonov et al. 2010 and 2012). It seem that it is important for the lamb to be at least 17 days of age, live weight, especially of twins or triplets to be > 7 kg and to consume some dry feed (80 – 100 g/d) at weaning time (Simeonov et al. 2010 and 2012; Krachunov et al. 2010).

ENTICE LAMBS TO DRY FEED AND PALATABILITY OF FEEDS

Different methods are applied to attract lambs to dry feed – locating feeding trough at well illuminated place, putting new shining steel bolts in the feeder, disperse dry milk powder or small quantity of salt above feed. The most effective method in our experiments is using small quantity milk powder to attract lambs to dry feed. We have used with smaller successfully old compact discs or steel bolts as entice. Lambs are playing with the metal object and putting their nose into the feed. There are not comparative studies to evaluate the effect of the mentioned methods for encouraging young lambs to start eating dry feed. Our observations are that all those methods help familiarization of lambs with the new for them dry feeds.

Testing palatability of different feeds Davies et al. (1974) find soybean meal the most preferred food for young lambs, followed by rolled barley, propriety pelleted feeds, fish meal, flaked maize, whole oats and sugar-beet pulp. Tait and Bryant (1973) reported that for young lambs whole grain is most acceptable and preferred to pellets. Risa (2010) reported the preferences of young lambs as followed: soybean meal, wheat bran, pelleted feeds with molasses, alfalfa hay, whole maize grains, whole oat, oat groats etc.

Ivanova et al.(2010) find that immediately before and after weaning at 20 – 30 days of age lambs' preference is in following order: whole maize, whole wheat, pelleted starter feed and whole barley.

It is evident that whole grain (maize, barley and wheat) and pelleted feed are among preferable feed for very young lambs. That way we base our experiments on pelleted protein concentrates and whole grain.

When pelleted protein concentrate (PPC) and whole grain are given separately, the intake of the two components is approximately in ratio 1:1 which is close to the proper balance of protein in the rations of lambs (Simeonov et al. 2010; 2012; Krachunov et al. 2010). For similar regulation of intake by lambs Kiriazakis and Oldham (1993) are reporting. However, Rodrigues et al. (2007) find higher intake of protein when high palatable soybean meal (Davies et al. 1974) is available *at libitum* to lambs. It seems that palatability of PPC used in experiments of Simeonov et al. (2010; 2012) and Krachunov et al. (2010) and whole grain are approximately equal.

Cleaning the trough of early weaned lambs every day and adding several times per day the new feed stimulate intake (Simeonov et al. 2010).

TESTING DIFFERENT PROTEIN SOURCES FOR YOUNG LAMBS

Early weaned lambs are essentially a non-ruminant, thus require dietary source of high quality protein, B-group vitamins and easy digestible carbohydrates, than mature ruminants. It is of interest to accelerate the development of rumen and use relatively cheap sources of protein from earlier

age. In some trials transition feed with dry milk or fish meal is used as a source of high quality protein. Another decision is applying the so called mix system of management with 12 – 15 h separation of lambs from dams, milking ewes and 9 – 12 h suckling daily, for a certain period before complete weaning and changing high quality milk protein with vegetable protein (Folman 1966; Papachristoforou, 1990; Gargouri et al. 1993).

After development of forestomachs 50 to 90% of amino acids absorbed from the intestine are of microbial origin (Smith, 1975). Generally microbial protein satisfies amino acid requirements except methionine and histidine (NRC, 2007). Storm and Orskov (1984) and Matras et al. (2000) find methionine and lysine as first and second limiting amino acids.

Experimental groups in the study of Ivanova et al. (2010), Simeonov et al. (2010), Krachunov et al. (2010) and Simeonov et al. (2012) received pelleted protein concentrate (PPC) (table 1).

Table 1. Composition of pelleted protein concentrates (PPC) with 30%CP

Items	Ivanova et al. (2010)	Simeonov et al. (2010)	Krachunov et al. (2010)			Simeonov et al. (2012)
			SBM	SFM	REX	
Ingredients, g.kg^{-1}						
DDGS*	640	656	650	650	550	0
Sunflower meal (SFM)	0	0	0	300#	0	500##
Rape expeller (REX)	0	0	0	0	200	0
Soybean meal, 44 (SBM)	300	300	300	0	200	205
Wheat	0	0	0	0	0	25
Limestone	25	25	25	25	25	25
NaCL	15	15	15	15	15	15
Premix	10	4	10	10	10	5
Ammonium sulfate	10	0	0	0	0	0

* Wheat dry distillers grain with solubles; # Sunflower meal contains 440 g.kg^{-1} and ## 350 g.kg^{-1} crude protein respectively

The main component of PPC was DDGS or sunflower meal (SFM). DDGS has light yellow-brownish color and low ADFN content (0.16 – 0.18% in DM), which means good quality DDGS with low damage of protein and lysine. DDGS is a good source of energy and protein for lambs (Schauer et al. 2005, 2006, 2008; Huls et al.2006; Archibeque et al. 2008) and can replace soybean meal and part of maize in lamb ration without changing performance and carcass quality.

DDGS is a source of low degradability protein into the rumen, but with low lysine content. It has good pelleting properties. To compensate for low lysine in DDGS soybean meal was included in PPC. For increasing water drinking and prevention of urolythiasis in male lambs higher level of common salt and

ammonium sulfate (in one experiment) was included in PPC. In the next trials ammonium sulfate was excluded. No cases of urolythiasis were found during the experiments.

Dies with holes of 4.2 mm were used for pelleting, except Ivanova et al. (2010) when 6 mm dies was used. Pellets were of excellent quality without breaking-up during transportation and manipulations, and being not too hard at the same time.

Results of feeding whole grain and PPC are shown in table 2.

Table 2. Performance of lamb and feed efficiency

Items	Ivanova et al. (2010)		Simeonov et al. (2010)		Krachunov et al. (2010), PPC#			Simeonov et al. (2012), PPC##		
	STM*	PPC#	STR**	PPC#	SBM	SFM	REX	Maize	Wheat	Barley
No. of lambs	13	13	23	23	11	11	11	13	13	13
Days of age	36	38	26.1	26.8	30	3	30	20.2	18.5	19.6
Days in trial	58	58	53	53	53	3	53	65.7	63.8	66.2
Initial weight, kg	11.2	11.4	10.5	10.6	12.6	12.6	12.4	8.66	8.95	9.04
Final weight, kg	27.6	27.5	26.2	27.7	27.0	25.3	25.8	25.9	27.0	26.6
Daily gain, g	286	268	211	297	272	239	254	262	283	265
UFV▼/ kg gain	3.78	3.64	3.19	3.19	3.87	3.73	3.54	3.81	4.00	4,14

*Pelleted starter feed with 2% skim milk until 20 kg live weight of lambs

**Starter without skim milk, not pelleted

#PPC – Pelleted protein concentrate (table 1) plus whole maize;

##PPC plus different whole grains.

▼Feed units for meat according to French system

Dressing percentage and quality of carcass were similar in groups of lambs fed with different starter diets in the four trials. The cost of PPC + whole grains per 1 kg of live weight gain is by 23% cheaper compared to feeding early weaned lambs with commercial starter feed (Ivanova et al. 2010)

It is difficult from those 4 experiments to make a conclusion about the effect of quality of protein on performance, feed efficiency and carcass quality. However, comparing different groups of experiment of Krachunov et al. (2010), as well results of the four trials carried at similar conditions shows a tendency for better gain when the level of lysine in diets is higher although the difference is not significant (P> 0.05). Data in literature also show small effect of the quality of protein, but most of the published data are with lambs above 30 days of age at the beginning of experiments.

Erickson et al. (1989a) find equal gain and gain to feed ratios of lambs receiving distillers grain or soybean meal as protein sources. The performance and carcass composition were equal when source of protein for early weaned lambs are soybean meal or meat and bone meal (Mansoa et al. 1998). Irshaid et al. (2003) reported that there is not difference in growth rate and feed

efficiency when feeding lambs with ration with soybean meal or sunflower meal as a protein sources.

Liamades and Stefos (1990) using soybean meal (SBM), SBM+ skim milk, SBM+ maize gluten meal as a protein sources for lambs weaned at 28 days of age do not find difference in performance. Performance of lambs is not changing by replacing soybean meal (SBM) with formaldehyde treated SBM (Hadjipanayiotou, 1992). Merchen et al. (1987) do not find difference in nitrogen metabolism of lamb receiving maize gluten or soybean meal as protein sources.

Even the presence of fish meal in the concentrate mixture does not lead to improvement of liveweight gain and feed to gain ratio in young lambs (Orskov, 1982; Hogue and Adam, 1982; Beermann et al.1986; Hassan and Bryant, 1986; Tan and Bryant, 1991; Hussein and Jordan, 1991; Hadjipanayiotou, 1992; Hadjipanayiotou et al 1996; Walz et al. 1998).

There is not consistent data concerning the effect of quality (amino acid composition) of protein sources on performance of lambs especially when high concentrate diet is fed *at libitum* to lambs. Reasons are not clear (Dabiri and Thonney, 2004). Degradability of protein is lower in such a feeding regime (Hoover, 1986) when pH in rumen is low (Loerch et al. 1983) and this may play a role. Askar et al. (2008) find increased efficiency of microbial protein synthesis in rumen when whole grain is fed to lambs. There are not enough data about the level and quality of protein for lambs weaned at 20 – 30 days of age, and above 7 – 8 kg live weight. This problem merits attention for further research. Predominant data show that the first limiting amino acid is lysine under Balkan area conditions when sunflower and distiller's grain are the main sources of supplementary protein (Krachunov et al. 2010).

SOURCES OF GRAIN (CARBOHYDRATES) FOR EARLY WEANED LAMBS

Different grains are not equal as feed. Maize and sorghum provide less protein and more starch compared to wheat and barley. Protein and starch are faster degradable in wheat and barley, than in maize and sorghum. Feeding results however do not show big differences in performance of young lambs receiving different grains.

Schwulst (1979 and 1980) reported equal performance of lambs fed wheat or sorghum grain in rations with 30% alfalfa hay. In the next publication (Schwulst, 1981**)** with 15% alfalfa hay, corn and sorghum are equal and superior to wheat. Hart and Doyle (1985) reported that wheat intake and rate of gain were lower, compared to lambs fed sorghum and maize. However, wheat grain in this experiment contains 14% cheat, which could be the reason for the worse result.

Daily live gain and feed efficiency are better for barley than for oats (Erickson et al. 1985), better for maize compared to barley (Erickson et al. 1985; 1988a 1988b; Rupprecht et al. 1992), approximately equal for corn and sorghum (Erickson et al. 1989; 1990) and approximately equal for barley and sorghum (Erickson et al. 1989).

According to daily live gain and feed to gain ratio in early weaned lambs, different cereals range in the following descending range: maize, wheat, sorghum, barley and oats (Orskov et al. 1974). However, the difference between maize, wheat, sorghum and barley is very small.

It is possible to conclude that daily gain and feed efficiency when feeding different grain is equal when intake of energy is equal (Kenney, 1986; Simeonov et al. 2012). In most of the trials with young lambs the difference between the most popular grains (maize, wheat, sorghum and barley) is very small if any.

PHYSICAL FORM OF DIETS

There is no significant difference in digestibility by lambs of whole, grounded and pelleted grain (Tait and Bryant, 1973). Orskov et al. (1974) find that it is true about maize, barley, wheat and oats. Hadjipanayiotou and Georghiades, (1985), Hadjipanayiotou (1990) and Economides et al. (1990) do not find differences in digestibility, nitrogen balance and performance of lambs fed whole, grounded or pelleted grain in rations of early weaned lambs. Askar et al. (2008) estimate equal microbial protein synthesis in the lamb rumen when ground or whole barley + protein supplement was fed. Results of Hadjipanayiotou (1990) are shown in table 3.

Table 3. The effect of barley grain processing on the performance of growing lambs

Items	PID.*	RGP*	WGP*
Weight gain, $g.d^{-1}$	344	341	323
Feed/gain	3.56	3.70	3.71

*PID - All ingredients in the diet are in pelleted form; RGP - Barley grain rolled other ingredients pelleted; WGP- Barley grain whole other ingredients pelleted

The whole barley supports equal or better daily gain and feed efficiency compared to ground (Tait and Bryant, 1973; Erickson et al. 1988a; 1989) or pelleted barley (Tait and Bryant, 1973; Hatfield, 1994). There are no advantages to steam rolling barley compared to whole barley (Morgan et al. 1991) in lamb rations. Orskov (1979) reported that any processing of cereal grains for mature and growing sheep is likely to be valueless, and suggested that cereal grains should be given whole.

In conclusion, there is no value to process grain, which can be fed as whole grain to lambs even in very early life.

IMPORTANCE OF FORAGES

There is different opinion on including forages in the diet of lambs. Poe et al. (1969) find that lambs fed roughage in creep had more rumeno-reticular tissue at 4 weeks and lost less weight after weaning than lambs fed concentrate in creep or milk only.

In our trials (Ivanova et al. 2010; Simeonov et al. 2010 and 2012; Krachunov et al. 2010) young lambs intake more hay than concentrate, but only for a few days after beginning to consume dry feeds. The quantity of hay intake is insignificant (1 – 3 g per lamb per day) before 7 days of age. Later intake of hay depends on its quality (table 4)

Table 4. Average hay intake per lamb at different age when they have at libitum concentrate and hay (data from 4 experiments carried out by the same scheme for early weaning)

Age, weeks	2*	3*	4	5	6	7	8	9	10	11	12	13	14	Ag#
Intake, g/d**														
Meadow hay, l.q.	8	11	65	70	72	77	82	77	81	76	75	73	75	75
Alfalfa hay, l.q.	6	9	73	93	112	124	135	136	138	148	144	150	147	127
Alfalfa hay, h.q.	7	10	74	96	117	169	197	140	164	187	175	183	189	154
Pea hay, h.q.	9	12	94	109	170	212	258	221	188	181	231	177	138	180
Average	7.5	11	77	92	118	146	168	144	143	148	156	146	137	134

*Suckling period; ** l.q. – low quality, h.q. – high quality; # - Average for 4 – 14 weeks

Consumption of hay is very low and doesn't have essential effect on nutrient supply. Obviously forage is not essential also for stimulation of chewing, saliva production and rumen motility when young lambs receive whole grain which keeps those functions at acceptable levels (Orskov et al. 1974; Orskov, 1979; Simeonov et al. 2012). Our unpublished experiments (Simeonov et al.) shows that offering wheat straw instead of alfalfa hay to early weaned lambs up to 25 kg live weight lead to increases of live weight gain because of decreasing intake of roughage and increasing consumption of concentrate. Doubt concerning needs of forage in the diet of early weaned lambs exists among other scientists, too (Umberger et al. 1986; Landa et al. 2001). This subject merit attentions of further research.

DRINKING WATER SUPPLY

Continuous access to drinking water is very important for early weaned lambs. Nevertheless, it is necessary to facilitate and encourage lambs to drink water, by positioning the drinking device on easy accessible well lighted place,

close to feeders. During cold whether it is necessary to ensure drinking water of about 12 – 20^0C temperature (N. Todorov, unpublished). Insufficient drinking is the main reason for rumen impaction and death of lambs in the first weeks when weaned at 15 – 20 days of age (Pond et al. 1982).

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