



Usage Opportunites of Total Mixed Ration (TMR) in Small and Large Ruminants

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Abstract

Total mixed ration (TMR) has been used in animal nutrition for many years around the world, it has recently started to take attention TMR is the consumption of a daily nutrient requirement of the animal as a whole mixture. The mixture should contain all the daily needs of the animal such as roughage, concentrated feed, vitamins, minerals etc. TMR provides benefits such as protection of rumen health, saving in feed costs, and controllability, as well as allowing the use of regional wastes as animal feed. In this way, difficulties in accessing quality roughage as a result of the decrease in water resources in the world and drought can be reduced. It is a feeding method that can be used in all ruminant animals. While the use of TMR offers some advantages to enterprises, there are also situations that can be considered as a disadvantage. In addition to studies such as comparing TMR with the traditional feeding method, adding different additives to TMR, packaged TMR studies have been carried out recently. TMR can be prepared fresh daily, or it can be preserved by making stretch packs (ensiled TMR) for longer storage. In this review, the use of TMR in ruminant animals such as dairy cattle, beef cattle, buffalo, sheep and goats has been examined in detail.

Keywords: Total Mixed Ration (TMR); Small Ruminant; Large Ruminant

Introduction

Animal requires balance diet for their growth and production during entire life. For this reason, the first condition for obtaining the desired yield from animals is nutrition. An adequate and balanced feeding model should be applied to obtain the desired yield. The first step to achieve this aim is to determine the animal's requirements. For this purpose, the optimum requirements should be determined by considering factors such as the age, sex, yield, duration of yield, live weight and climatic condition of the animals. For this, the animal should be evaluated in terms of fattening, milk, breeding or wool-mohair yield. Because as the yield type changes, the calculation methods for determine the animal's needs are required to change [2].

The factors like the age, lactation period, milking day, live weight, milk composition and environmental conditions should be

taken into consideration to determine the nutrient requirements of dairy cattle. All of these factors should be considered in the needs calculation. Otherwise, the animal's requirements will not be determined correctly. It will be sufficient to evaluate the age, live weight, number of days of gestation in determining the nutrient requirements of cows in the dry period. Determination of nutrient requirements of beef cattle is not as complex as in dairy cows. The requirements calculation should be made by considering age, fattening period, live weight, aim of daily live weight gain and aim of cutting time in beef cattle. As it is known, the aim of the beef cattle is to achieve the highest live weight gain in the shortest time [10].

One of method applied globally for balanced diet for animals is TMR. The TMR is a balanced diet form that is formed by formulating roughage, concentrated feed, by-products, vitamins and minerals together as a mixture and mixing them well [4,12,38]. TMR

is a nutrition method used in almost every country in the world. In Türkiye it is used successfully in enterprises over 100 animals. However, it is not preferred in small farm under 100 animals [42].

Among the advantages of using TMR are

- Animals consume homogeneously mixed feed.
- Less digestive problems, especially in the transition periods.
- Provided suitable environment for rumen health.
- Requires minimal labor.
- Possibility to evaluate regional wastes [38,39].

In addition to the advantages, there are also issues that can be considered as disadvantages.

These includes;

- Large particle size roughage needs to pre-mixing.
- Requires additional equipment such as mixer [11,39].

Some points should be considered during TMR preparation.

- During the first mixing, the feeds should not be contaminated with any pathogen and the tools and equipment to be used in the mixture should be clean.
- It is also important to know the real nutrients by analyzing the feedstuffs to be prepared. After these analyzes are made, a ration that will meet the requirements of the animals should be calculated using a professional ration software program [51].
- During the preparation of the mixture, the standby time of the feeds in the mixer is also important. This period must be between a minimum of 3 minutes and a maximum of 14 minutes. Because TMR feed sizes affect the consumption and digestion of animals [6,12].
- After the TMR is prepared, it should be consumed by animals in a short time. Considering that the most suitable dry matter content of TMR is 45-60% [38], deterioration will come true quickly. As a matter of fact, it is seen in the studies that the TMR dry matter is in the range of 40-55% [7,13,48].

In recent years, ensiled TMR studies have attracted attention to prevent rapid deterioration. It is widely preferred in Japan, China, South Korea, Vietnam, Thailand, Indonesia, Nepal, Israel, Italy, South Africa, Argentina and Brazil around the world. The ensiled TMR is easy to transport and store as it can durable for a long time. In this way, it has the potential to be a commercial product by being formed in small structures such as bales-packages and to be used easily in small enterprises [4]. Ensiled TMR has become common in recent years, as it maintains high moisture feeds as well as im-

proves aerobic stability even when siled alone [19]. Chen., *et al.* [7] stated that TMR based on oat or common vetch can be well stored in silage with or without additives. Moreover Li., *et al.* [25] stated that since alfalfa cannot be produced enough in China, TMR silage can compensate for this deficiency. It has been stated that the use of ensiled TMR instead of fresh TMR can improve lactation performance in dairy cattle, since it increases nutrient digestibility [30]. Use of additives is not mandatory when TMR is established in a balanced way. Therefore, ensiled TMR in this way is a good protection method and labor saving for small enterprises [49].

In Turkey, a pilot study was conducted in the Amasya region and it was seen that the ensiled TMR could be kept intact for at least 42 days [42] and it was started to be used by small enterprises [3].

Use of TMR in dairy cattle

In ruminants, dairy cattle gives better productivity and efficiency by using TMR. It can be said that dairy cows need balanced and mixed quality roughage, because cattle are more prone to acidosis due to the high level of concentrate consumption, as a part of selective feeding [52]. Due to this reason, many studies have been conducted on the diversification of TMR and the use of regional byproducts in dairy cattle ration. Sarker., *et al.* [38] examined the effects of conventional feeding and TMR in 20 dairy cattle in early lactation period. Feeding with TMR resulted in a significant increase in milk yield and quality, as well as a reduction in simultaneous milk costs. Pastorini., *et al.* [32] determined the effects of increasing rate of fresh grass in TMR on dry matter consumption on twelve dairy cattle, they reported that adding fresh grass up to 29% to TMR did not affect milk yield and dry matter consumption. In a study conducted to the effect of TMR distribution frequency on milk yield and its components in 40 Finnish Ayrshire cows [28], it was stated that feeding once and 5 times a day had no effect on milk yield and composition. In the study examined to the effects of different storage conditions and feed processing techniques of TMR on feed consumption, digestion and lactation performance in 8 Holstein cows [30], it has been stated that ensiled TMR increased digestion and milk production, although it had a negative effect on nitrogen digestion compared to fresh. In addition, in the same study, it was determined that the steam flake method of the grain used in freshly consumed TMR had an increasing effect on digestion, milk yield and milk protein compared to dry grinding. Casper., *et al.* [5] examined the effect of cobalt in 24 late lactation Holstein cows; cobalt carbonate and cobalt lactate had no effect on increasing lactation performance in cows fed with TMR containing high

amounts of roughage. In the comparison of yogurt made from the milk of cows fed with conventional feeding and those fed with TMR, it was determined that yogurt made from cow's milk fed with TMR contains more acetaldehyde, which make it more solid and durable [17]. It is seen that TMR is a convenient and less costly feeding method in feeding dairy cows.

Use of TMR in calves

Milk is mainly nutrition source of calves in early stage of life. In addition to milk, there are also enterprises that prefer to calf starter feed and quality roughage as a supplement. TMR studies were carried out to examine the development of calves during and after the weaning. In a study examined the development of pelleted and non-pelleted form of oat hay based TMR in 4 d old thirty calves [15], calves consumed only starter concentrate, unpelleted oat hay + starter feed added to milk, and pelleted oat hay added to milk + starter feed. Weaning age and feed conversion ratio of calves were tended to decrease in consuming pelleted TMR. This suggests that the digestibility of pelleted TMR may be higher in calves. The effect of TMR roughage rate and size is examined in 28 weaned calves on behavioral characteristics [34], it has been stated that the size of roughage consumed by male calves during development period should be carefully considered to support normal behavior and positive welfare. It is seen that there are few studies on calves and TMR can also be preferred in calf feeding.

Use of TMR in beef cattle and heifers

A limited number of studies have been found with TMR in the feeding of heifers. In a study conducted with 8-12 month old 18 heifers to investigate the feed consumption and digestion of wheat straw based TMR and treated with urea ammonium wheat straw-based TMR [31], the development of heifers fed with treated urea and non treated urea TMR was better than fed traditionally. DeVries and VonKeyserlingk [8] examined the optimal feeding strategies in 6 Holstein heifers. Heifers fed with separate grain and hay, mixed grain and hay and TMR. As a result of the study, TMR promotes balanced feed intake in growing heifers.

Sunarso, *et al.* [41] examined the effect of TMR on 20 male cross-grade cattle and it has been stated that TMR is a method with probable potential in the feeding of beef cattle. In order to examine the effects of adding urea to TMR and ensiled TMR on the developmental performance of beef cattle, in a study conducted in 5-7

months old 27 male Holstein calves [47], the calves were fed conventionally with a ration containing concentrated and urea-free forage, TMR containing 1.5% urea, and ensiled TMR. As a result of the study, feed consumption, digestibility and daily live weight gain were found to be higher in calves fed with TMR supplemented with urea. In the study [12] conducted to the effects of the physical active neutral detergent fiber effect of the feed on the growth and digestibility of the feed of six month old 54 Holstein beef cattle fed with TMR, it was concluded that the TMR mixing time is important in feed consumption and daily live weight gain. In a study examined to the effects of different feeding methods on 21 month old 15 Holstein steers cattle [44], it was stated that the carcass quality and sensory characteristics of calves fed with TMR were better. TMR is also a viable method in the feeding of beef cattle and heifers

Use of TMR in buffaloes

Since buffaloes generally have low productivity, they are fed in grassland and by extensive feeding method. However, studies have been carried out on intensive breeding and use of TMR in countries where buffalo breeding is intense. It has been stated that the use of locally available inexpensive feed materials in TMR positively affects the development of buffalo calves and reduces the cost of feeding [43]. Performance and nutrient digestibility of 24 male buffalo calves (9-12 month old) were investigated by treating some of the wheat straw in TMR with fungus [40]. As a result of the study, it was stated that the 33% mushroom treatment of wheat straw in TMR increased the growth performance and digestibility. Daily DM consumption was found to be significantly higher in the group fed with TMR in buffalo calves compared to the conventional group [46]. In a study conducted to the effects of feeding 18 buffalo heifers (220 d old) with TMR, which includes different energy levels, on dry matter (DM) consumption, live weight gain (LWG), daily live weight gain (DLWG), feed conversion ratio (FCR), and body condition score (BCS) [20], it has been stated that feeding heifers with TMR containing 12% more energy than the NRC recommendation provided 800 g of DLWG, and feeding with TMR containing NRC 112% energy was increased FCR. It has been determined that adding exogenous fibrolytic enzyme to TMR increases nutrient digestibility in adult buffalo bull rations regardless of the roughage-concentrated feed ratio [35]. Also adding exogenous fibrolytic enzyme or live yeast into TMR increases the concentration of rumen metabolites in buffalo bulls [33]. Jha, *et al.* [18] examined to traditional and TMR methods of feeding 20 lactating buffaloes,

feeding with TMR significantly increased milk yield and quality in buffaloes, while at the same time it caused a decrease in milk production costs. In a study conducted the effects of adding green grass into TMR to mozzarella in the feeding of 32 lactating buffalo whose milk is produced mozzarella cheese [45], it was stated that adding green grass into TMR is a low-cost feeding strategy to improve healthy buffalo mozzarella production. It has been stated that feeding buffaloes in lactation with TMR silage increases economic buffalo milk production compared to conventional or TMR feeding [37]. Although it is not common in Turkey, TMR can also be used in buffalo feeding.

Use of TMR in sheep

Many studies have been conducted on the effect of content and size of TMR in sheep and goats. In a study [29] conducted to the effects of varying sizes of different roughages in TMR on performance, fermentation and fatty acid composition of *M. Longissimus dorsi* in 25 lambs were investigated, it was stated that feed consumption and body weight gain increased in lambs fed with TMR of 1 cm size and normal size *alfalfa*, and rumen fermentation ability was developed positively. When the consumption of TMR's containing mushroom compost, soybean pulp, pomegranate pulp, grape pulp and avocado pulp in lambs was examined, it has been stated that the highest DM consumption was in the group containing grape pulp [9]. In a study [22] examined the feed consumption, digestibility, N use and rumen fermentation characteristics of date residues instead of barley in Atriplex hay based TMR ration in sheep were investigated. It was stated that 100% date waste instead of barley increased the use of N, thus increasing digestibility and microbial protein synthesis. It was determined that adding 2.5 g/day of live yeast to the rations of sheep fed with TMR improved ruminal fermentation and increased performance significantly [20]. Xu., *et al.* [50], examined the feed consumption, performance and profitability of different ration types in 24 yearling sheep, the animals grazed traditionally on oat hay, oat silage, TMR and pasture. As a result of the study, it was stated that TMR is a suitable method for increasing feed consumption, performance, feed conversion ratio and profitability. İslam., *et al.* [16], stated that feeding the sheep with pelleted TMR will perform better and the meat yield capacity will increase. In the study, one year old 6 local sheep investigated and it is seen that TMR is a suitable feeding method in sheep feeding despite grazing in the pasture.

Use of TMR in goats

Studies have been conducted to investigate the effects of TMR on goats as well as sheep. It was determined that adding 2% herbal feed additive to TMR in 5 months old 8 male kids caused an increase in N fractions, volatile fatty acid level, rumen fermentation efficiency, digestibility, high slaughter body weight and dressing percentages [14]. As a result of the study [23] TMR is an ideal economic ration for goats. In a study [36], conducted to the effects of different roughages in TMR on *in vitro* rumen fermentation and methane production in 8 goats [36], the best results were obtained from timothy grass and alfalfa grass, also they stated that the roughage-concentrated ratio in TMR gives the best results in the ratio of 50:50. Adiwiranti., *et al.* [1] examined to the feeding behavior and water drinking activities of goats, and they were fed with high fiber natural grass hay and low fiber TMR. As a result of the study, it was observed that the ration containing high fiber took longer to consume and thus caused low feed consumption. In addition, it has been determined that animals that consume TMR consume more water. In a study examined to the effects of *Leucaena leucocephala* plant instead of oilseed meal into TMR in 30 lactating Saanen dairy goats and 16 castrated Saanen male goats [24], it was stated that the plant did not cause any adverse conditions in dairy goats, and also did not affect carcass characteristics and meat quality. Malik., *et al.* [26] conducted to the effects of the physical form of pellet and conventionally prepared TMR on feed consumption, performance, total digestibility and blood parameters in 32 fattening goats. As a result of the study, it has been stated that pelleted TMR containing wheat straw increased DM consumption and performance. In addition, it was stated that adding 15% wheat straw to the ration gives better results. In a different study [27], reported that goats fed pelleted TMR had better rumen papilla length and density than those fed conventional TMR.

Conclusion

In the studies, it has been observed that the TMR feeding method is used in the nutrition for almost all ruminants. This feeding method, which has been applied in the world for many years. In addition, ensiled TMR has also started to be used. As a result of the studies, the widespread use of TMR in Turkey provides low-cost feeding opportunities, as well as the opportunity to store for a long time by packaging and offer it to the use of small family enterprises. It is thought that not only dairy cattle breeders, but also beef cattle,

sheep, goat and buffalo breeders can benefit from this. As a result, it is thought that the use of TMR and ensiled TMR is important for a balanced ration, healthy rumen environment, labor savings and most importantly low cost for Turkey, which is not rich in pasture, has limited quality roughage resources and is grown periodically.

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