Obtaining and quality of pre-dried ryegrass

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ABSTRACT
The possibility of using annual cold season grasses for the production of pre-dried is justified by the nutritional value of these forages, such as ryegrass, and because they do not compete in relation to planting areas with grain crops. Obtaining pre-drying subjects the plants to cutting and wilting for subsequent silage. Aspects such as water content, nutritional value, buffering capacity and soluble carbohydrate contents of the forage to be ensiled as pre-dried interfere with the speed of dehydration, fermentation processes and quality of the pre-dried obtained. In addition to these, factors such as forage fertilization, care in storage and supply of preserved forage also affect the quality of the final product offered to the animals. However, it is possible to obtain pre-dried products of high nutritional value from ryegrass forage and the adoption of wilting techniques and forage conservation in anaerobiosis.

Keywords: Nutritional composition, Conserved forage, Lolium multiflorum, Ruminants.

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INTRODUCTION

In animal production systems, feed represents most of the costs, and it is essential to search for alternatives applicable to the field that minimize expenses and promote efficient performance. In the supply of forage to ruminants throughout the year, there is the occurrence of productive seasonality, caused by the drop in temperature and luminosity. This scenario contrasts with the drop in animal productivity and one of the alternatives found by man to overcome production losses during this critical period is the conservation of forages (Fluck *et al*., 2018).

Among the storage practices commonly employed by cattle breeders, haymaking, silage and baling stand out. Such processes aim to preserve the quality of natural matter with minimal losses during drying and storage (Meinerz *et al*., 2015). However, compared to silage production, the haying method presents some obstacles that can compromise the final quality of the forage obtained. Among these, the longer time of exposure to the air and greater demand for equipment and labor stand out. In this context, and in order to reduce the risks and costs that the haymaking process presents, an interesting option for the conservation of forage is pre-drying. In this technique, the forage is pre-dried with subsequent baling and packaging, obtaining the anaerobic environment necessary for fermentation (Nath *et al*., 2018).

Pre-drying is an extremely necessary step for the preparation of forages for the production of pre-dried, because coinciding with the vegetative phase of greater nutritional value, the plants have a high percentage of moisture. In this way, the partial removal of water ensures a low incidence of secondary fermentations and a lower loss of nutrients by effluents during storage (McDonald; Henderson; Heron, 1991; Nath *et al*., 2018). However, changes occur in the chemical composition of plants during the drying, gathering and storage process (Jobim *et al.,* 2007).

Several forages can be used for the production of pre-dried, including summer and winter grasses and legumes. Ryegrass (*Lolium multiflorum*) has high potential for pre-dried production, due to its ability to adapt to different climatic conditions and speed of dehydration. In addition, it has a high proportion of leaves and thin stems and is recognized for its productive and nutritive properties (Pedroso *et al*., 2004; Pellegrini *et al*., 2010; Oliveira *et al.,* 2015). Several cultivars (cv) of ryegrass are known, and among them, there is great genetic variability, which is reflected in different yields, nutritional composition, ability to adapt to the planting environment and resistance to diseases (Balocchi; Lopez, 2009; Cassol *et al.,* 2011). Increased yield, chemical composition and digestibility of forages are also observed when fertilization is applied to the soil and tillering of plants (Carvalho *et al*., 2004).

In regions of the country where the cultivation of summer crops such as soybeans and corn is practiced, it is common among producers to take advantage of the residual effect of nitrogen fertilization. On these occasions, the practice of base fertilization is not carried out in the implantation of grasses, only top dressing, which can negatively affect the growth and bromatological composition of the plants (Cassol *et al.,* 2011).

In this context, studies are needed to identify fertilization strategies for forages with potential for silage and to evaluate the losses resulting from the drying process of this material, aiming to increase the productivity and quality of the final product. Thus, the objective of this review is to highlight the potential of the use of pre-drying with forage conservation technique, as well as the factors that interfere in the quality of the pre-dried products obtained, especially the pre-dried ryegrass products.

LITERATURE REVIEW

PRESERVATION OF ROUGHAGE FEED FOR RUMINANTS

Ruminants have the ability to transform roughage feed that does not compete with human consumption into sources of energy, protein, minerals and other nutrients necessary to supply animal metabolism and meet production demands. Grasses are valuable sources of nutrients for ruminants, and the competitiveness of Brazilian livestock activity is largely related to animal production on pasture, considered the most economical livestock system (Barcellos *et al*., 2008; Skonieski *et al.,* 2011).

It is not only a recurring problem in Brazil that the drop in animal productivity during the forage season period is a recurring problem. As it is an inevitable period that is repeated every year, as it occurs due to climatic factors, producers must be prepared for these. Among other practices, the preservation of food through silage has generated excellent results, due to the ease of processing, storage and the final quality of the product, when well conducted (Dantas; Negrão, 2010).

When it comes to the preservation of food for the production of roughage in Brazil, we have at our disposal several plants and processes used for this purpose, such as sorghum, millet, corn, grass and hay silages of different forages. Regarding silage, the corn plant is the most used forage because it has high dry matter production per area, good nutritional quality, and adequate bromatological composition for storage (Ribeiro Junior *et al.,* 2011). However, the growth and development of corn are limited by water, temperature and luminosity, and its planting is feasible in the rainy season (Cruz *et al.,* 2010). Thus, the possibility of using annual cold season grasses for the production of pre-dried crops is justified by the fact that these forages do not compete in relation to planting areas with grain crops. Even in grazing systems, the surplus of forage can also be used, conserving biomass for times with limited food (Villalobos; Arce, 2016).

The storage of pre-dried grasses in Brazil has gained more followers in recent years, and the most used plants are elephant grass, brachiaria, oats, ryegrass and the genera *Cynodon* and *Panicum* (Evangelista *et al*., 2004; Dantas; Negrão, 2010; Oliveira *et al*., 2015). However, the low concentrations of soluble sugars and dry matter in the vegetative stage of the plant, which is the ideal point for cutting, contribute to the high buffering power during the fermentation process of grasses (Muck, 1990). Due to these limitations, the ensiling process of green grasses presents undesirable characteristics, as they favor the occurrence of secondary fermentations, resulting in quantitative and qualitative losses (McDonald; Henserson; Heron, 1991). In these cases, the process of drying the plant, aiming to reduce humidity before the material is ensiled, is essential to obtain a quality roughage.

PRE-DRYING PROCESS

Aiming at the quality of grass silage, including pre-dried, pre-drying, or also called plant wilting, is an extremely necessary process in conservation, as it provides a reduction in the water available in the forage, improving the fermentative aspects Nath *et al.* (2018) and reducing effluent losses (Van Soest, 1994). In this technique, the removal of moisture from the plant consists of the partial removal of water from the forage, through exposure to the sun with or without movements, when it has high levels, that is, greater than 600 g/kg (60%).

Through pre-drying, the cutting of the plants can be carried out during the vegetative period, which ensures higher protein levels when compared to the haymaking process. In haymaking, the plants are cut at the beginning of the reproductive stage, to obtain higher DM levels in the harvested forage. Also, compared to pre-drying, haying causes greater protein losses due to the longer time of exposure to the sun, which leads to the development of the *Maillard reaction* (Van Soest, 1994).

In the vegetative period, when the cut for silage occurs, the forage plants have moisture content between 80 and 85%, and soon after the cut, the forage is spread in the field, where the moisture is quickly reduced to 65% through losses by the stomata, because the loss of water is intense in plants that are still alive. After death, the plant continues to lose water through the cuticle, and the collection of grasses is carried out when the plants reach humidity close to 45% (Moser, 1995). Reaching the required dry matter content, the forage is collected and ensiled and the product generated from this process is called pre-dried or *haylage*, which means in English an intermediate between hay and silage (*hay* = *hay and silage* = silage).

Plant dehydration is influenced by some environmental parameters, which are inherent to the plant itself and management, which optimize or impair the conservation of forage quality. During the loss of moisture from the plant to the field, right after cutting, solar radiation, temperature, air humidity and wind speed directly interfere with the drying rate, and the exposure to the field is adjusted for periods of 4 to 6 hours (Rotz, 1995). The cuticle is a waxy layer that covers the surface of plants and prevents the occurrence of physical damage, as well as reducing the loss of plant components by leaching and excess moisture. Stomata are also important in plant dehydration, being the pathway through which approximately 85% of the total water inside the plant is lost, even after cutting (Rotz *et al*, 1994; Neres; Ames, 2015).

The plants show a decrease in the leaf/stem ratio, as well as a decrease in nutritional quality and water content according to the advance in vegetative development, changing the time required for dehydration of the plant according to age (Van Soest, 1994). For the pre-drying process, the low moisture content in the plant is favorable to accelerate dehydration, but it is detrimental in relation to the nutritional quality of the pre-dried. The management carried out in the field, such as turning and turning the raked material, if carried out in the first hours after cutting, helps in the rapid loss of moisture, as they provide greater air circulation (Bayão *et al*, 2016).

For the storage of pre-dried, different processes are used, and it can be preserved in the form of rolls or bales covered with a special plastic film or in silos with the use of tarpaulins for sealing, which have the common purpose of keeping the food in anaerobic ensuring the quality of the green forage.

PRE-DRIED IN BRAZIL

Brazil has an extensive territorial area, with more than 850 million ha, representing approximately 20% of the total arable land in the world (Batista Filho, 2007; IBGE, 2017). Availability of area combined with favorable climatic conditions for the development of several plants, results in enormous potential for the production of food at low cost (Ferraz; Felicío, 2010). Standing out worldwide for cattle breeding (ABIEC, 2016). Pasture-based ruminant feed is affected by seasonal fluctuations in forage production throughout the year. These fluctuations, associated with the lack of food planning of the properties, increase the costs with the acquisition of concentrates in order to supply the nutritional deficits of the animals in these critical periods.

As an alternative to the production of corn silage, roughage widely used by producers, the use of silage from other forages such as sugarcane, grasses and legumes has been highlighted. Conserved forages are important sources of energy for animals throughout the year, but they are extremely important in periods of low supply of natural or planted pastures (Bernardes; Chizzotti, 2012; Ribeiro Junior *et al.,* 2011).

Fluck *et al*. (2018), when studying ryegrass silage before and after four months of fermentation, observed that the bromatological composition of the pre-dried was similar to that of the green material, thus demonstrating the efficiency of the conservation method. However, the production of pre-dried products of this forage comes up against obstacles such as the high water content, and the lower DM production per hectare when compared to tropical forages. Also, information on losses throughout the production process and responses to fertilization under particular climate conditions are not disclosed in the scientific community.

In a study evaluating the quality of pre-dried marandu grass (BRS Piatã and BRS Paiaguás) with or without the addition of legume (Estilosante Campo Grande), it was observed that all pre-dried cattle presented satisfactory quality for the requirements of cattle in maintenance, even without the addition of legumes (Epifanio *et al*., 2016). In the pre-dried with the inclusion of 30% of legume, the fermentation process occurred adequately, which favors the obtaining of preserved forage with higher nutritional quality.

The conservation of Tifton 85 as pre-dried had good results according to the study by Neres *et al*. (2014). With a dry matter content of approximately 28%, the forage presented the best crude protein contents, pH and lower ammonia production. In the same work, evaluating the use of additives in the pre-dried, the researchers observed that the inclusion of soybean hulls increased the crude protein contents and the use of corn pounds promoted a reduction in the values of Neutral Detergent Fiber (NDF).

FACTORS INFLUENCING THE QUALITY OF PRE-DRYING

The challenge in ruminant feeding is to increase the intake capacity without harming the rumen, and the neutral detergent fiber (NDF) exerts a great interaction with intake, influencing the faster emptying of the rumen as the NDF content in the feed is lower (Velho *et al*., 2007). By characterizing the cell wall of plants, according to Van Soest (1994), ensuring pre-dried plants with levels of NDF similar to those of the original forage suggests efficiency in the conservation of its nutrients. This is a significant challenge in the production of preserved forages, due to the diversity of factors that can influence their nutritional value.

Initially, soil conditions, climate and fertilization act on forage quality, providing lower nutritional value the more adverse the conditions of the factors mentioned during plant growth. Sowing fertilization, especially in soils of medium/low fertility, stimulates forage production and nutritional value by providing a greater balance between the nutrients absorbed by the plants. In topdressing, the application of nitrogen under any fertilizer formulation increases in addition to productivity, the cell content of the plants, increasing the CP levels and reducing the cell wall. Relevant aspects in management decisions, as the structural organization of the plant and the tissues that constitute it, influence its digestibility, which is directly related to the bromatological composition (Carvalho; Pires, 2008).

After cutting, during the period in which the plants are exposed to the sun for drying, nutrient losses occur, because according to Van Soest (1994), heat causes losses in dry matter, and especially in protein digestibility due to the *Maillard* reaction. Forages whose temperatures do not exceed 5 to 8ºC at room temperature are considered to be free of protein losses caused by overheating (Kung *et al.,* 2018).

In this context, the shorter the time of exposure to the sun's rays of the forage after cutting, in order to achieve the moisture content necessary for silage, the less changes will be in the nutritional value of the plant. During pre-drying, the dry matter content is increased, a process that in addition to benefits for fermentation, also contributes to the reduction of enzymatic activity in plant cells, reducing nutritional losses.

After baling and plastic packaging of the pre-dried, the anaerobic environment is installed in the silo or rolls. This, associated with the DM conditions obtained in the pre-drying, provides conditions for the growth of lactic acid bacteria and inhibition of the growth of undesirable microorganisms (Nath *et al.,* 2018). Lactic acid bacteria cause a reduction in pH, which in the absence of oxygen ensures the preservation of the pre-dried forage.

During the storage of pre-dried forage, the presence of undesirable microorganisms is detrimental to the quality of the roughage, due to the competition for substrates with lactic acid bacteria (McDonald; Henderson; Heron, 1991). Also, in stored hays, nutritional changes were observed, such as the consumption of soluble carbohydrates, and in their depletion, the use of pentoses present in hemicellulose for the generation of energy by the remaining microorganisms. In pre-dried, a similar process occurs, but always allowed to fermentation conditions.

USE OF FERTILIZATION IN THE QUALITY OF PRE-DRIED FORAGES AND FERMENTATION

The application of fertilization in the soil during forage establishment aims to meet the nutrient needs of the plant, aiming to increase its productivity. According to Lopes *et al*. (2006), to reach one ton of dry matter, ryegrass needs 20-30 kg of Nitrogen, 6-10 kg of Phosphorus in the form of P2O5 and 25-35 kg of Potassium in the form of $K_{2O.}$ Phosphorus (P) and Potassium (K) are essential elements in plant diet, playing important roles in plant metabolism. Phosphorus participates mainly in the development of roots and cell multiplication, which reflects on the productivity of cultures. Potassium, on the other hand, acts in physiological metabolism, such as in the regulation of the opening and closing of stomata, transport and storage of carbohydrates, synthesis of proteins and starch, and its functions are important in the induction phase of the plant (Tibau, 1983).

Among the minerals, nitrogen is the one that most limits the productive performance of grasses, as it is fundamental to plant growth, and therefore, they have high demands when seeking to increase forage production (Lupatini *et al*., 1998). This element is found in low concentrations in the soil, and mostly unavailable, requiring the practice of nitrogen fertilization prior to sowing, also called base fertilization. Nitrogen fertilization, when applied at the beginning of tillering, influences the productivity and growth speed of forages (Skonieski *et al.,* 2011). In the southern region of Brazil, where there are extensive areas planted with crops such as soybean and corn, it is common among producers to take advantage of the residual effect of nitrogen fertilization provided to these summer crops, and there is no practice of base fertilization in these situations, which can negatively affect plant growth (Cassol *et al.,* 2011).

Cover fertilization at the beginning of ryegrass tillering responds to a higher density and faster growth of the plants, since the tillering time of this forage occurs in the fall, and due to the drop in temperature, it impairs the release of nitrogen originating from the soil (Carvalho *et al*., 2004). In the study by Pellegrini *et al*. (2010), evaluating the effect of four levels of nitrogen fertilization (0, 75, 150 and 225 Kg/N/ha) on the yield and quality of ryegrass pastures, found that the dry matter production per hectare (DM/ha) increased linearly with the evaluated N rates, with yields of 4203; 5696, 6851 and 7778 Kg/DM/ha according to the nitrogen increment. Pavinato *et al*. (2014), also found a linear increase in the yield of ryegrass, cv Barjumbo, in relation to nitrogen fertilization applications. It was observed in this work that the highest dose of fertilizer (120 Kg) used was the one that presented the maximum yield between the doses of 0, 40, 80 and 120 Kg/N/ha studied, with a production of 5250 Kg/DM/ha.

Soares and Restle (2002) observed that nitrogen fertilization provided the maximum dry matter production in triticale and ryegrass pasture at a dose of 300 Kg/N/ha (7877 Kg/DM/ha), and at a dose of 450 Kg of N/ha, there was a reduction in dry matter production (7662 Kg DM/ha), when compared to the dose of 300 Kg. The plant species used to make the pre-dried also influence the final quality of the material. Tropical climate grasses (C4), because they fix more carbon in their structure, have high dry matter yields, but the content of indigestible compounds is higher when compared to temperate climate plants (C3), due to the lower cell wall thickness of C3 grasses (Moreira, 2006).

USE OF RYEGRASS FOR PRE-DRYING

Ryegrass (*Lolium multiflorum*) is characterized by a forage species belonging to the Poaceae family. Its probable origin is the Mediterranean Basin, arriving in Brazil through Italian immigrants in 1875 (Floss, 1988). It is a temperate climate grass currently cultivated worldwide for various purposes (Son *et al*., 2019). In Brazil, it is quite widespread in the South Region, being used mainly as pasture (Medeiros; Nabinger, 2001).

It is an annual grass of route C3, with a fasciculated root system and cespitous habit, and can reach 1.2 meters in height, with cylindrical and erect stalks, whose height can reach 60 centimeters. Its leaves are thin, soft and shiny, with a width of 2 to 4 mm. The sheaths are cylindrical and the young leaves are curled. The ligule is short and the auricles are hugging. The inflorescence is through two rows of spikelets, 15 to 20 cm long, containing about 40 spikelets, with 10 to 20 fertile flowers per spike (Carvalho *et al*., 2004; Cauduro *et al*., 2007). The large-scale use of this forage is due to its adaptation to the climate, with an ideal temperature for its development of around 18 to 20°C, high forage production, regrowth and nutritional quality (Pedroso *et al*., 2004; Pellegrini *et al*., 2010).

There is a huge supply of ryegrass cultivars on the market, and the main difference between them is genetic, classifying the varieties into diploid and tetraploid. The natural species of ryegrass are presented in the diploid form (2n=2x=14chromosomes) and through genetic improvement, chromosomal duplication was carried out, with the production of tetraploid varieties (2n=4x=28 chromosomes), with the objective of increasing the traits of agronomic interest. In this way, chromosomal duplication increases cell volume, and thus, cellular components such as water, soluble carbohydrate contents, proteins and lipids are increased, which leads to better digestibility indexes (Smith *et al.,* 2001; Balocchi; López, 2009). Thus, with a larger cell volume, the average weight of a thousand seeds in tetraploid cultivars is 3 to 4.5 g against 2 to 2.5 g for diploid cultivars (Balasko *et al*., 1995).

Ryegrass is a forage that has good palatability, with high values of protein, minerals and high digestibility. The flowering season is usually in September and has a great capacity for natural reseeding. Productivity varies with the management applied, and may exceed 10 tons of DM/ha (Carvalho *et al*., 2007). Due to the little diffusion of the practice of pre-drying of grasses in Brazil, studies related to this process are still scarce. The studies that refer to the preparation of pre-dried products have mostly the use of elephant grass and *Panicum maximum* for this purpose, due to the high availability of these forages in the country (Dantas; Negrão, 2010).

Ryegrass has great potential for the production of good quality pre-dried, because according to Tamburini *et al.* (1995), who evaluated the bromatological composition of different pre-dried crops (wheat, rye, triticale, barley and ryegrass), concluded that the digestibility and crude protein content in the pre-dried ryegrass was higher than the rest of the crops. Also in the same research, the authors observed that the cereals had higher dry matter yields than the pre-dried ryegrass. Conaghan; O'Kiely; O' Mara (2010) observed that the pre-dried of two perennial ryegrass cultivars (AberDart and Fennema) had better fermentations when the concentration of soluble carbohydrates in the dry matter was higher, which indicates that tetraploid varieties have greater potential for the production of pre-dried with high quality.

FINAL CONSIDERATIONS

The conservation of forages in the form of pre-dried is a potential alternative for the storage of quality forages. And among the factors that affect this quality, the forage species stands out, where ryegrass stands out for its nutritional value, in addition to fertilization and care in the process of production, obtaining and storing pre-dried.

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