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Review Article

Review on Preservation and Utilization of Wet Brewery Spent Grain as Concentrate Replacement Feed for Lactating Dairy Cows

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Abstract | The objective of this review is to document an effective preservation and utilization strategy of wet brewery grain as alternative feed for high cost concentrate feeds. In many areas, getting feed with less costs and maximizing profitability becomes a great concern for dairy farmers. Wet brewery grain is one of the cheapest protein rich agro-industrial by-product in Ethiopia. The short lifespan of the wet brewery grain associated with its high moisture content is the critical problem of farmers in utilizing the by-product. On the other hand, cost of drying is one challenge which leads farmers to directly use wet brewery grain. It is found that ensiling of wet brewery grain alone and with other feed is ecologically acceptable, economically feasible and easily applicable technology to dairy farmers in developing country. Therefore, reviewing different preservation mechanisms and documenting of different strategy is very crucial for storing and utilizing this abundant feed without spoilage. The review is aimed at documenting the existing strategies for preservation of wet brewery grain to apply strategies in the country context for tackling feed shortage, preventing environmental pollution and improve productivity of dairy cows in the country.

Keywords | Feed preservation, Feed utilization, Dairy cows, Wet brewery grain.

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INTRODUCTION

In Ethiopia, the major constraint for low productivity of dairy cows is the shortage of livestock feeds in terms of quantity and quality, especially during the dry season (Ahmed et al., 2010). With the increasing cost of concentrate feed stuffs and growing demand for dairy products, alternative feedstuffs has become a great necessity in the dairy industry. Due to the rapid expansion of brewery factories and its environmentally friend nature, brewery by-products, have become an option to dairy managers looking for alternative feedstuffs (Bell et al, 2012).

A wide variety of agro-industrial by-products are available in bulky extents which have significant nutritional potential. Brewery waste (Brewers' grains) is a representative example of such unrealized potential. Spent grains are the by-products of mashing procedure, which is one of the preliminary processes in brewery in order to solubilize the malt and cereal grains to confirm sufficient extraction of the water with extracted matter (Fillaudeau et al., 2006). After diverse separation methods, the quantity of brewers' spent grain (BSG) generated could be about 85% of the total by-products (Tang et al., 2009).

Wet brewery grain is the most abundant brewing by-product, which accounts around 85% of total by-products generated (Aliyu and Bala, 2011). Kombolcha and Dashen brewery factories of Amhara region of Ethiopia produces about 13,414 tons of wet brewery spent grain annually (Firew and Getnet, 2010). Brewer's spent grain (BSG) is a readily available, high volume low cost by-product of brewing and is a potentially valuable resource for industrial exploitation (Robertson et al., 2010).

The main restrictive aspect of effective use of wet brewery grain is its little dry matter content, which hampers storage and utilization (López & Pascual, 1981). Due to the high moisture content of the feed, storage of the feed under normal environmental conditions (temperature, aerobic conditions etc) as commonly adopted on farms, is suitable for the development of micro-organisms such as mycelial fungi and unicellular yeasts, promoting the decomposition of the by-product stored under these conditions (Allen et al., 1975).

In Ethiopia, brewery dried grains are used widely for dairy cattle feeding especially near to brewery factory like Gondar, Debre Birhan and their surroundings to tackle the high price of protein rich concentrates. According to (Varela, 2006), Dashen brewery factory in the Amhara region produces around 3,356 tons of brewery grain on DM basis annually and the brewery by-product is low in cost for smallholder farmers to use as protein supplement in diets. Though farmers were using the by-product in dried form, the energy cost associated with drying resulted in increased feeding of brewery wet grains.

The main problem of utilizing brewery wet gain is rapid molding and spoilage within few days of production. Therefore, documenting an efficient preservation strategy is found to be crucial to utilize wet brewery spent grain appropriately without spoilage. However, data is very scarce on preservation of brewery wet grain and technological applications used by farmers to prevent its spoilage in Ethiopia.

The main aim of this review is to document the existing preservation strategies so as to prevent spoilage of vastly used and highly available wet brewery grain and to ensure consistent supply of protein-rich feed for cows.

PRESERVATION AND UTILIZATION OF WET BREWERY SPENT GRAIN

Nutritional Properties of Wet Brewery Spent Grain

The WBG are the by-product of the beer-brewing industry. These are the spent grains, most often barely, but sometimes corn and rice may be included depending on the source of the grains (Thomas et al., 2016). They have low dry matter (20 to 32 %) content, a significant protein source, and have a high content of total digestible nutrients (TDN) due to the digestibility of the available fiber (Hersom, 2006). The high fiber content of WBG is associated with the elimination of starches and sugars from the barley grain during the malting process leaving largely the structural cell-wall carbohydrates of hemicellulose and cellulose (Westendorf and Wohlt 2002). WBG are a good source of protein with a crude protein content that ranges from 25 to 34% (Thomas et al., 2016). The protein is mainly placed in the germ portion of the spent grain and is digested to a partial amount in the rumen and to a greater amount in the small intestinal tract. The concentration of rumen degradable protein ranges from 28-43% (mean 35%), indicating that wet brewery grains are good sources of rumen un-degradable or "bypass-protein" and it has 20-32 % dry matter (Thomas et al., 2016). Feeding wet brewery spent grain to dairy cows is a worthwhile opportunity for dairy farmers to offer additional rumen un-degradable protein and energy to dairy cows, with equal or enhanced milk production (Zanton, 2016).

Existing Strategies for Preservation of Wet Brewery Spent Grain

Brewery wet grains have been utilized as feed for animals for many years (Szponar et al., 2003). However, high moisture content of wet brewery grain (80 to 85%) makes the by-product particularly susceptible to microbial growth and subsequent spoilage in a short period of time (7 to 10 days) (Stojceska et al., 2008). Different strategies are being implemented in different areas and the major preservation and utilization mechanisms are detailed in subsequent section.

Drying of Wet Brewery Spent Grain.

Several methods have been proposed to prolong brewers' wet spent grain storage time as a result of its high moisture content. Drying has been the most effective method of preserving wet brewery grain. However, energy costs associated with drying have resulted in increased feeding of wet brewers' spent grain. According to (Conrad and Rogers, 1977), brewery wet grains are used more efficiently for milk production than dried grains. Preservation of wet brewery grain by drying method has the advantage of reducing the product volume, and decreases transport and storage costs. Most of the time processing using two-step drying technique, where the water content is first reduced to less than 60% by pressing, followed by drying to ensure the moisture content is below 10% is used by many brewery plants (Santos et al., 2003).

Conservation by oven-drying or freeze-drying reduces the bulk of the product and does not change its chemical composition, while freezing is inappropriate as it affects the proportion and chemical composition of some sugars such as arabinose. Nevertheless, in general, freeze-drying is economically not feasible at the large scale; making the oven-drying to be the ideal technique (Bartolome et al., 2002). According to (Tang et al., 2005), superheated steam technique has several advantages including the reduction in the environmental impact, an enhancement in drying efficiency, the exclusion of fire or explosion risk, and a re-

covery of valuable volatile organic compounds.

Ensiling of Wet Brewery Spent Grain.

An efficient alternative for the storage and utilization of wet brewery spent grain without spoilage would be ensiling anaerobically. It ensures anaerobic fermentation for lactic acid, reduction in pH and, consequently, preservation of the quality of ensiled material (Souza et al., 2012). Wet brewery grain can be ensiled in combination with dry feed resources or alone depending on the interest of cattle producers (FAO, 2011).

According to (Kindbom, 2012), the procedure to be followed during ensiling of wet brewery grain alone is as follows. First, trenches of a total volume of each 1 cubic meter should be dug around farm of dairy farmers. The amount of trench to be prepared depends on the size of the farm and availability of land. After some day's latter, polythene plastic should be bought from market and brewery grain would be ordered from the industry. Each trench found in different area, requires 12 square meters polythene sheets and has capacity to ensile 750 kg of wet brewery grain (Kindbom, 2012). Trenches would be covered with polythene sheets appropriately to avoid contamination with soil. Wet brewery grain should be added on the prepared trench, compacted and then covered, so as to provide an air-tight atmosphere. Soil should be put upon the top layer of the sheet to protect it from birds and to prevent air from entering the trench. Finally, wet brewery spent grain ensiled for 28 days will be ready for feeding of cows.

The key feature of ensiling wet brewery grain is that it can be done easily by farmers after the commencement of the training and all the required materials are available locally. Moreover, low cost silage-making technique was tested and found to be applicable by farmers in developing country due to low-cost and use of locally-available materials and its improvement in milk production and income of farmers (FAO, 2011).

Ecological Sustainability of Ensiling of Wet Brewery Grain

Ensiling of wet brewery grain utilizes by-product of brewery industry which is the fastest growing industry in Ethiopia as a min input. Preserving wet brewery grain is not only important for avoiding spoilage in terms of feeding but also vital to avoid the environmental population of unpreserved wet brewery grains in and around the industry area. Unless the grain is preserved and utilized properly, fresh brewer's grains left on the ground outside the brewery spoil quickly and can become an environmental nuisance, including water pollution. Using brewers grains as animal feed alleviates the environmental impact of the brewing process (Lazarevich et al., 2010; Pappu et al., 2007). Rapid spoilage of wet brewery spent grain which results air and water pollution is associated with the high moisture content of the feed.

CONCLUSION

Based on the finding of this review, it can be concluded that wet brewery spent grain can be preserved and utilized without spoilage. The mechanisms by which wet brewery grains can be preserved includes, drying with solar radiation, ensiling alone and ensiling with other dry forages. Among the methods used for preservation, drying by solar radiation is found to be difficult which is associated with the cost of drying. Therefore, ensiling wet brewery grain alone and with other dry fodders are the recommended practices for dairy farmers especially in developing country.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest for the contents in the manuscript.

AUTHORS' CONTRIBUTION

The Authors worked cooperatively during the collection of information related to this review paper.

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