

Influence of Drying on the Stability of Meals from *Morus alba* Linn

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Abstract

The objective of the study was to evaluate the influence of the drying type (under sunlight and under shade) on the quality of the meals from *Morus alba* Linn, six months after their elaboration. For such purpose, a complete randomized design was used with two treatments (drying under sunlight and under shade) with seven replicas each to establish the difference between the indicators: residual dry matter, crude protein, neutral and acid detergent fiber, cellulose, lignin and ash, at the moment of obtaining such meals and after six months of conservation in glass flasks with screw tops at room temperature. After storage the residual dry matter varied significantly, in the treatment under sunlight as well as under shade. So did the crude protein, cellulose and acid detergent fiber, in higher degree in the treatments under shade. In all the cases an adequate product for animal consumption was obtained. The treatment under shade is more appropriate for tropical and rainy countries.

Keywords: Meal conservation; Dehydration under shade; *Morus alba* Linn; Protein plant

Introduction

Around 70% of the expenses in contemporary animal production systems are due to the acquisition of the utilized feedstuffs. In the systems specialized in monogastric animals the price of the protein of the raw materials used oscillates between 60 and 80% of the value of such feedstuffs (Guerrero-Mackliff, 2021). Hence the use of meals, elaborated from forage shrubs and trees, constitutes an alternative to lower costs without reducing the achievement of the foreseen productive parameters and indicators (Shahzad et al., 2020; Quinto-Espinoza, 2021).

For such purpose, during years, the meals obtained from *Morus alba* Linn, protein forage with high production of edible biomass and high nutritional value (Martín et al., 2014; Ruíz et al., 2014), have been incorporated to the animal diet. This option has as limitation the deterioration of the quality of these products because of humidity, particularly in countries with rainy climate (Scull-Rodríguez et al., 2021, Redacción Tierras, 2021). In Cuba the rainy season lasts approximately 180 days, which propitiates the deterioration of the quality of these natural products.

In relatively recent date, Montejo-Sierra et al. (2018) studied the effects of drying under sunlight and under shade of diverse forages, including *Morus alba* Linn. The quality of the dehydrated and ground edible biomass (meal) was determined through a proximal

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chemical analysis, which included dry matter (DM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), cellulose, lignin and ash, according to the rules of AOAC International (2006). The objective of this work was to evaluate the influence of drying type on the stability of meals from *Morus alba* Linn six months after their elaboration.

Materials and Methods

Location of the experiments

The research was conducted at the Pastures and Forages Research Station Indio Hatuey, of the Perico municipality, Matanzas province, Cuba (22°50'12.26" N, 81°02'25.99" W), at 19 m.a.s.l.

Design and experimental treatments

In order to evaluate the effect of drying (sunlight or shade) on the stability of the meal from *Morus alba* Linn., the procedure described here was followed. The corresponding meals, obtained by Montejo-Sierra *et al.* (2018), were put in glass flasks with screw top under laboratory conditions during six months. After this time, a chemical proximal analysis was performed on them including residual dry

matter (RDM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, lignin and ash. All the determinations were made according to the guidelines of the Association of Official Analytical Chemist (AOAC, 2006). A complete randomized design was used with two treatments (drying under sunlight and under shade) with seven replicas each.

Statistical processing

The difference between the indicators of the proximal analysis of the quality of the meals from *Morus alba* Linn newly-elaborated and after their storage for six months, was established through mean comparison by Student's t-test.

Results and Discussion

The evaluation of the bromatological indicators performed on the meals from *Morus alba* Linn after their storage during six months showed the variation of four of them in the one dried under sunlight as well as under shade. In three of them there was higher significance in the one dried under shade (Table).

Treatment	Drying Under Sunlight				Drying Under Shade			
BI	IV	VAS	SE ±	Cons.	IV	VAS	SE ±	Cons.
RDM	87,3I	92,6	0,24***	106,1	88,2	93,3	0,3***	105,8
CP	14,2	12,1	1,07*	85,2	14,5	12,4	0,86**	85,5
NDF	46	47,5	2,13	103,3	47,6	47,0	2,14	98,7
ADF	33,1	28,6	1,54**	86,4	33,8	26,8	1,71***	79,3
Cel.	25,5	22,2	1,95*	87,1	26,8	21,5	1,31***	80,2
Lig.	5,9	6,4	1,07	108,5	6,0	5,4	1,21	90,0
Ash	9,4	9,3	0,3	98,9	9,9	9,7	0,68	98,0

Legend: BI: bromatological indicators; IV: values obtained in the fresh meal (Montejo-Sierra *et al.*, 2018); VAS: values after storage during six months; RDM: residual dry matter; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; Cel.: cellulose; Lig.: lignin; Cons.: conservation; * indicates significant difference ($P < 0,05$), ** very significant ($P < 0,01$) *** highly significant ($P < 0,001$)

Table 1: Effect of storage on the bromatological indicators (%) of the meal from *M. Alba* dehydrated under sunlight and under shade.

Drying under sunlight is a natural form to process the biomass produced by plants. In countries like Cuba it constitutes an economical option of utilizing strong solar radiations. Its limitation lies on climate variability, especially in the rainy season, which can lead to the loss of raw material due to rotting. The use of solar dryers, although requiring an initial investment on them, allows to prevent this risk and simplifies the process (Martín, 2017). The other choice, which also utilizes the characteristics of the Cuban climate, consists in drying in the shade under roof. Although it implies a delay in the drying time, it avoids feed losses due to unexpected rains and the extra labor to store the foliage and to put it back under sunlight. Once the biomass is put to be dried, it is not gathered again until it is dry to be stored (Agüero-Cabrera *et al.*, 2020).

Dehydration implies a loss of intracellular water (more remarkable when drying takes place under sunlight and the meal is elaborated) and intercellular water (less perceptible drying occurs under shade, during the conservation time of the meal). When drying takes place under sunlight, the high temperatures and radiations destroy thermolabile compounds, denature enzymes, damage the biological activity of the cell and deteriorate other qualities that should be preserved (Largo-Ávila, 2020). In the drying under shade these processes are less drastic and disadvantageous (Flores-Chana, 2021) for making the moringa tree meal.

The evaporation of intercellular water over 85%, due to dehydration, prevents the development of microorganisms that affect the bromatological quality of meals and cause rotting (Carvajal-Salcedo and Cuesta Peralta, 2016; Crouble-González, 2017). The moisture values obtained in this study are between 15 and 20%, which guarantees minimum losses (Martínez-Fernández, 2016; Campo-Vera *et al.*, 2018). When this process is done correctly, like in this case, adequate conservation is achieved, with minimum losses in the quality of the preserved material, as proven by three of the evaluated indicators (Table). The reasons that cause the variations in the other four indicators are explained below.

The loss of intracellular water after dehydration (during the six months of storage) leads to the solids being more concentrated and thus there is an increase in the values of residual dry matter. Cova *et al.* (2009) reported a similar performance when evaluating the variations in time of this indicator in the meal from *Eisenia* spp.

Crude protein, acid detergent fiber and cellulose showed a significant decrease when comparing them with those reported for fresh meal (Montejo-Sierra *et al.*, 2018), difference that increases in the values calculated for drying under shade. Their decrease is related to the endogenous and biological enzymatic activity (cell survival) which degrades the available molecules because there is lower deterioration and invasion of the integrity of the cell tissue that is favored by drying under shade (Crouble-González, 2017; Flores-Chana, 2021). The values calculated for crude protein may have also been influenced by the non-structural nitrogen that is volatilized as ammonia or ammonium because the product was stored at room temperature.

The significant decrease of the acid detergent fiber and cellulose values with storage, particularly in the meal derived from forage dried under shade, is consequence of the low evaporation rate of intracellular water. It conditions higher aqueous activity inside the tissue which favors oxidation reactions and increase of sugar metabolism in response to hydric stress caused by drying (Scholz *et al.*, 2019). The reduction of both indicators implies, from the nutritional point of view, an improvement of the nutritional value of the product as there is higher quantity of nutrients that can be assimilated by the animals (Ordoñez *et al.* 2021). The high ADF concentrations are associated with low rumen digestibility (Portillo-López *et al.*, 2019; Panadero *et al.*, 2021).

The drying of *Morus alba* Linn forages, under sunlight as well as under shade, allows their conservation as meals for animal feeding. The meals, after six months of storage, maintain the most commonly evaluated bromatological indicators within the admissible ranges for these products. Drying under shade is better adapted to the climate conditions of tropical rainy countries such as Cuba (Montejo-Sierra *et al.*, 2018).

Conclusions

Drying under shade as well as under sunlight of the *Morus alba* Linn foliage allows the storage of meals that preserve their bromatological indicators during six months. The choice under shade is more adequate for tropical rainy climates.

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