Effect of Conservation Technic and Storage Period on the Fiber Content: NDF ADF ADL for Sugar Beet Pulp

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ABSTRACT

To preserve a fodder supposes to stabilize it as well as possible, in order to be able to store it several weeks or several months without it not deteriorating and that it preserves its initial food value at the fresh state. This stabilization can be obtained by dry mode or by silage process. The objective of this article was to present in which degree these various techniques will modify the food value of fodder and more precisely the contents of parietal components; we evoked in our case pressed sugar beet pulp, dehydrated pulp in the form of pellets and ensiled pulp. The got results made it possible to deduce in the case of the ensilage which the microbial activity favored the hydrolysis of the most soluble substances of fiber during fermentation that and by consequence it cause a drop in the content of fiber to neutral detergent NDF and of Hemicellulose on the other hand this lactic fermentation made increase the content of cellulose, ADF and lignin. Also the values of the NDF, the ADF and the ADL are higher in the silages in balls of 450Kg by comparing them with the bags of ensilages of 50Kg on the other hand the contents of hemicellulose and cellulose is slightly lower in the balls of 450 kg than in the bags of 50 kg. This study as made it possible to say as the contents of the ADF, the NDF, the ADL, cellulose and hemicellulose in the pulp preserved by silage are approximate to the contents of pulp on the outlet side of the press (T0) and are higher than the contents in pellets
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Key Words: Sugar beet pulp, silage, drying, NDF, ADF, ADL.

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1. INTRODUCTION

The sugar beet after its reduction in cossettes and pressing during the industrial process becomes, a combination of two matrices, the juice which will be transformed into sugar and pressed pulps which are heterogeneous structures made up mainly of structural glucids, and contain the major part of the parietal components: cellulose, hemicellulose and lignin. They compose together the fraction called "vegetable walls" quantified in the form of "NDF".

The vegetable matters rich in fiber are frequently introduced into food of cattle in particular for their beneficial effects on digestive operation [1] like for their energy contributions. In the ruminants, differences in the quantity and the physical and chemical properties of fiber in food can affect the performance and the productivity of animals, in particular to deteriorate fermentations in the paunch, metabolism, lipid level in milk produces, and finally long-term animal health [2] .

These fibrous vegetable matters have many advantages on the economic and environmental plan [3]. However, a reasonable use requires a precise characterization of the fibrous fraction. The term "fiber food" defines a heterogeneous family of polysaccharides wish the biochemical and physicochemical characteristics varied [4] that makes their analysis complex [5].

Several methods make it possible to quantify fiber, the Van Soest's methods makes it possible to separate the fractions "neutral detergent fiber" (NDF), "acid detergent fiber" (ADF) and "acid detergent lignin" (ADL) soluble in neutral or acid solutions.

The beet pulp conservation by drying in the form of pellets or fermentation lactic anaerobic in the form of ensilage as well as the processes of fermentation which are associated there, play a considerable part on the chemical composition of the whole of the vegetable walls. The study of the influence of these factors on the chemical composition of pulp is thus essential before formulating rations for the ruminants. It is in this context, this study aims to determine the effect of storage time and conditioning mode on fibrous contents (NDF, ADF, ADL, cellulose and hemicellulose) of the sugar beet pulp preserved by silage, also to see the effect of conservation mode (drying or silage) on fibrous content..

2. MATERIALS AND METHODS

2.1 Samples:

Sugar beet pulp was collected from Cosumar (SUTA) Company in Beni Mellal zones in Moroco in May, August and November 2014.

The samples of pulps were preserved according to 2 modes: by drying (pellets: with 85% DM) and by silage (with 26% DM).

Pulps are strongly hydrated at the outlet side of the press, their moisture is variable, according to the press capacities and the pulps physical characteristics which change with the beet quality and the diffusion conditions. This moisture varies between 70 and 80%.

In drying, wet pulp is brewed by a parallel hot gas current which makes it possible to remove a significant amount of water. Pulp is dried to dry matter content 87 to 88%. With these dry matters, pulp can be preserved under the environmental conditions. Pressed dried pulp takes the shape of cylindrical pellets of 18 or 22 mm diameter and 50 to 80 mm length. The pellets on the outlet side of the drier cooled and bagged in polyethylene bags of approximately 50 kg.

In the silage, wet pulp is preserved under anaerobic conditions in order to cause a lactic acidification of the medium thus supporting better a safeguarding of the food value of pulp. Ensiled pulps are bagged in bags of 50Kg and balls of polyethylene 450Kg.

The analysis of the various components is carried out by a series of extractions with alkaline and acid reagents, each one being able to extract a component by leaving the other intact ones.

2.1 Detergent Neutral fiber NDF

In 1967, Van Soest and Wine [6] publish for the first time a method to isolate the fraction from insoluble fibers (insoluble dietary fiber) coming from the cellular walls of plants, including cellulose, hemicellulose and lignin. The universally accepted definition of NDF, in connection with the non-ruminant and herbivores, is the following one: NDF is the organic fraction of the diet outside of rough ashes which is indigestible or slowly digestible and which occupies of the place in the gastro-intestinal tube. This definition of NDF includes the complex polysaccharides with sluggish fermentation, coming from cellular walls, such as cellulose and hemicellulose, but excludes the polysaccharides with accelerated fermentations, such as pectin, as well as the soluble polysaccharides (fructanes, etc).

Procedure for NDF determination:

Grind the air dried sample to pass 1 mm screen, weigh in a crucible 1 g of grinded sample with 1 mg approximation. Add 100 ml of neutral detergent solution at room temperature into crucible with 0.5 g of sodium sulfite and some drops of n-octanol. Heat at reflux 60 minutes onset of boiling. Filter and wash 3 times with boiling water, then twice with cold acetone. Dry 8 hours at 105 °C and let cool in a desiccator. Weigh.

Calculate neutral detergent fiber:

NDF % = (weight of crucible + weight of residue) - weight of crucible / weight of sample x 100.

2.2. Detergent Acid fiber ADF

ADF is an empirical method, published [7] like stage preliminary to the determination of lignin [7]. An acid treatment is applied in this method to avoid the lignin losses which are soluble in the alkaline solutions. The cation detergent, bromide of cetyl trimethyl ammonium, allows the separation of proteins of the fibrous residue. Like CF, ADF isolates mainly cellulose and lignin, but not

hemicellulose. Moreover, some pectin's with accelerated fermentation can precipitate in the strongly acid solution, which can induce values of ADF higher than NDF, especially in samples with strong content pectin (tender alfalfa, citrus fruits pulp) [8] [9].

Procedure for ADF determination:

Grind the air dried sample to pass 1 mm screen. Weigh in a crucible 1 g of grinded sample with 1 mg approximation. Add 100 ml of acid detergent solution at room temperature and some drops of n-octanol. Heat at reflux 60 min after start boiling. Filter and wash 3 times with boiling water, then twice with cold acetone. Dry 8 hours at 105 °C and let cool in a desiccator. Weigh.

Calculate acid detergent fiber:

ADF % = (weight of crucible + weight of residue) - weight of crucible / weight of sample x 100.

2.3. Acid detergent lignin ADL

Lignin represents the fraction of completely indigestible NDF. The method is based on the solubilization of cellulose by 72% sulfuric acid.

ADL procedure:

Grind the air dried sample to pass 1 mm screen. Weigh in a crucible 1 g of grinded sample with 1 mg approximation. Add 100 ml of acid detergent solution at room temperature and some drops of n-octanol. Heat at reflux 60 minutes after start boiling. Filter and wash 3 times with boiling water, then twice with cold acetone. (Note: it is possible to start using the residue of acid detergent fiber determination (ADF): Former method). After add 25 ml about of 72% sulfuric acid at room temperature (solvent for cellulose) and carry on cool extraction during 3 hours, stirring every hour, filter and wash 3times with boiling water or until acid reaction is no more present. Dry 8 hours at 105 °C and let cool in a desiccator. Weigh.

Calculate acid detergent lignin:

ADL % = (weight of crucible + weight of residue) - weight of crucible / weight of sample x 100.

2.4. Hemicellulose and cellulose

Hemicellulose is generally estimated by the difference: NDF minus ADF. However the cellulose is estimated by the difference between ADF and ADL. The sequential analysis, initially NDF then ADF on the residue and finally lignin, make it possible to carry out more precise determinations of hemicellulose and cellulose.

3. RESULTS AND DISCUSSION

The results presented in table 3.1 indicate for analysis of NDF that the value found in our study (42,49 % DM)concerning pressed pulp is approximate to that of bibliography; it is located between a maximal value of about 49.3% DM following French feed database[10] and minimal value of about 35.8 % DM following Ueli Wyss and Catherine Metthez 2014 [11].

Table 3.1. Content of pressed, ensiled and dehydrated sugar beet pulp.

	Period	% NDF	% ADF	% ADL
Pressed beet pulp	T0	42,4975	24,2244	1,3255
Ensiled beet pulp	T3	41,299	24,4345	1,7545
	T6	40,39	25,3548	1,757
	T12	40,12	26	2,75
Deshydrated beet pulp :	**Pellets**	32,44	17,46	1,2

In the case of ensiled pulp, the value of the NDF during the 3 times :T3, T6 and T12 (41,299%; 40,39% ; 40,12%) is located between a maximal value of about 54.6% following French feed database [10] and minimal value of about 38.9% following the same database.

For the pellets (dehydrated pulp), the value found in our study (32,44%) is slightly lower than the values found in the bibliography whose maximal value is about 50.9% following T.Gidenne & al. [12] and the minimal value is about 40.5% following Sauvant D & al. [13].

The value of ADF found in our study concerning pressed pulp (24,22%) is approximate to that of the bibliography; it is located between a maximal value of about 24.8% following AFZ [10] and minimal value of about 21% following Ueli Wyss and Catherine Metthez [11].

In the case of ensiled pulp, the content of ADF during the 3 times: T3, T6 and T12 (24,43%; 25,3548%; 26%) is very approximate to the bibliography; it is located between a maximal value of about 26.1% following AFZ [10] and minimal value of about 22.2% following the same reference.

For pellets (dehydrated pulp), the value found in our study(17,46 %) is slightly lower than the values found in the literature whose maximal value max is about 23.1% according to T. Gidenne & al. [12] and the minimal value is about 19.6% following the same author.

For ADL we notices that the value found in our study (1, 32 %) concerning pressed pulp is lower than that found by Guy Legrand [14] who is about 3.8%.

In the case of ensiled pulp, the value of ADL during the 2 times: T3 and T6 (1,75%; 1,757%; 2,75%) is approximate to the bibliography and it is located between a maximal value of about 2% following AFZ [10] and minimal value of about 1.2% following the same reference. For the T12 period the value of the ADL is high compared to the maximal value cited.

For pellets (dehydrated pulp), the value found (1,2%) is slightly lower than the values in the bibliography; whose maximal value is about 2.2%DM according to T. Gidenne & al [12] and the minimal value is about 1.9%DM following Sauvant D & al. [13].

Effect of the storage period of pulp in the silage form:

The graph in figure 3.1 presents the evolution of the parietal components of pulp throughout its storage from the exit of the press at T0 time up to one year at T12 time (T3 time represents 3 months of storage and T6 after 6 months of storage).
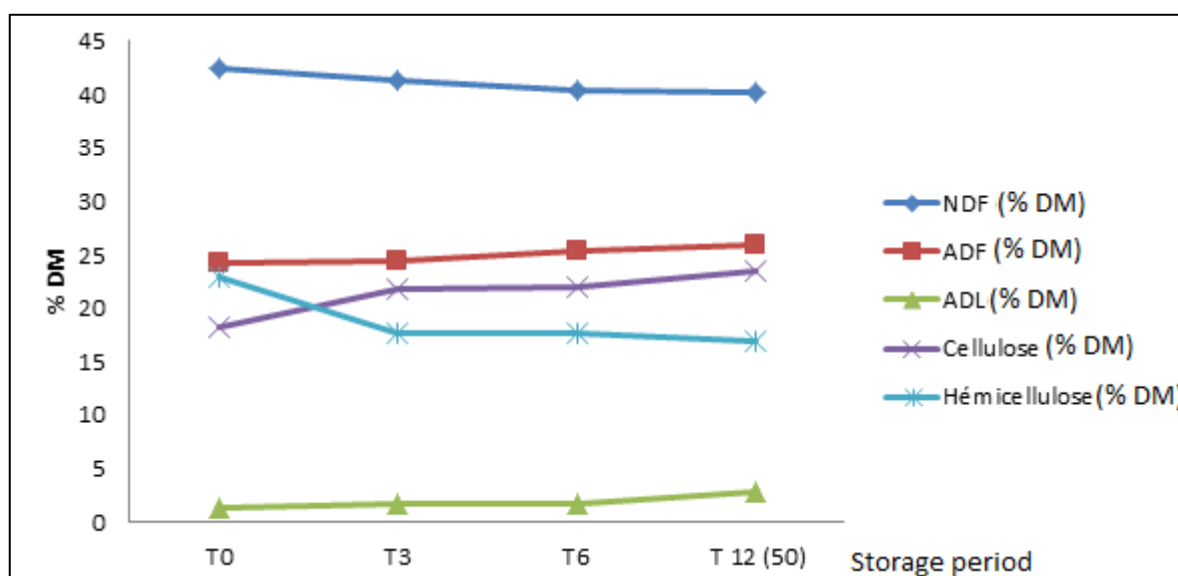

Figure 3.1: Effect of the storage period on the evolution of parietal sugars of the sugar beet pulp in the silage form

According to the graph we notice fiber with neutral detergent NDF knew a light reduction, it varied little since it was of a value of 42.49% DM before the bagging of silage at T0 time, 41.29%DM after 3mois of ensilage, 40.39%DM after 6mois of ensilage and finally of 40.12%DM after 12 months of ensilage.

For the ADF and the ADL we notice a same evolution along the period of ensilage from the exit of press where the values were respectively 24.22%DM and 1.32% DM up to 12 months of ensilage where the values become 26 and 2.75%DM.

In addition the cellulose increases since T0 time (18.27%DM) until T3 time (21.86%DM) and beyond this period the increase is less important, almost stable, until T12 time.

But the hemicellulose decreases since T0 time when the value was 22.89%DM until T3 time when the content was about 17.68%DM but thereafter that remains almost stable until T12 time with 17%DM.

The microbial activity favored the hydrolysis of the most soluble substances of fiber during fermentation we speak in this case about a part of hemicellulose. This last and according to the importance of its hydrolysis by hemicellulases of plant generally makes lower the content of fiber to neutral detergent NDF.
It is noticed that fermentation generally increases the content lignin of pulp. Since lignin is non digestible, this increase is the reflection of the loss of the dry matter resulting from fermentation.

The cellulose also increased since it is generally not hydrolyzed during fermentation, in parallel the ADF knew a weak variation but in the same way that of cellulose and it is completely normal since the cellulose is constituent the parietal major one of the ADF. This weak variation is a sign of well-preserved silage.

Effect of the mode of conditioning:

In figure 3.2 we compare the various parietal components of the ensiled pulp conditioned in two forms: balls of 450 kg and bags of 50 kg both out of polyethylene, after 12 months of storage.
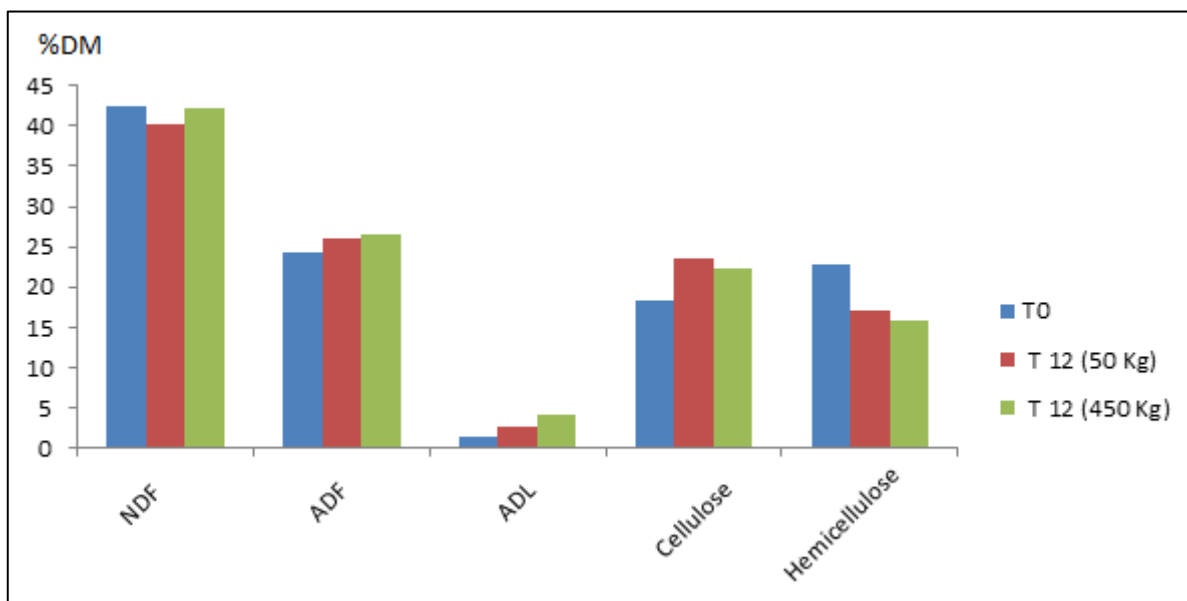

Figure 3.2. : Comparison between the composition of parietal sugars of the pulp ensiled in bags of 50 and 450 kg after 12 months.

According to the diagram of figure 3.2, we observe that the one year silage of beet pulp in balls of 450 kg represents values of ADF, ADL and Cellulose higher of those of pulp on the outlet side of press but the NDF and hemicellulose values decreased.

As it is noticed as the values of NDF, ADF and ADL are higher in balls of 450 Kg by comparing them with the bags of 50Kg. On the other hand the contents of hemicellulose and cellulose are slightly lower in the balls of 450 kg than in the bags of 50 kg.

Effect of the conservation technic:

The figure 3.3 presents the comparison of the various parietal components of the beet pulp subjected to two techniques of conservation: drying (pellets) and silage. Ensiled pulp is represented by the average of contents in T3, T6 periods and T12.
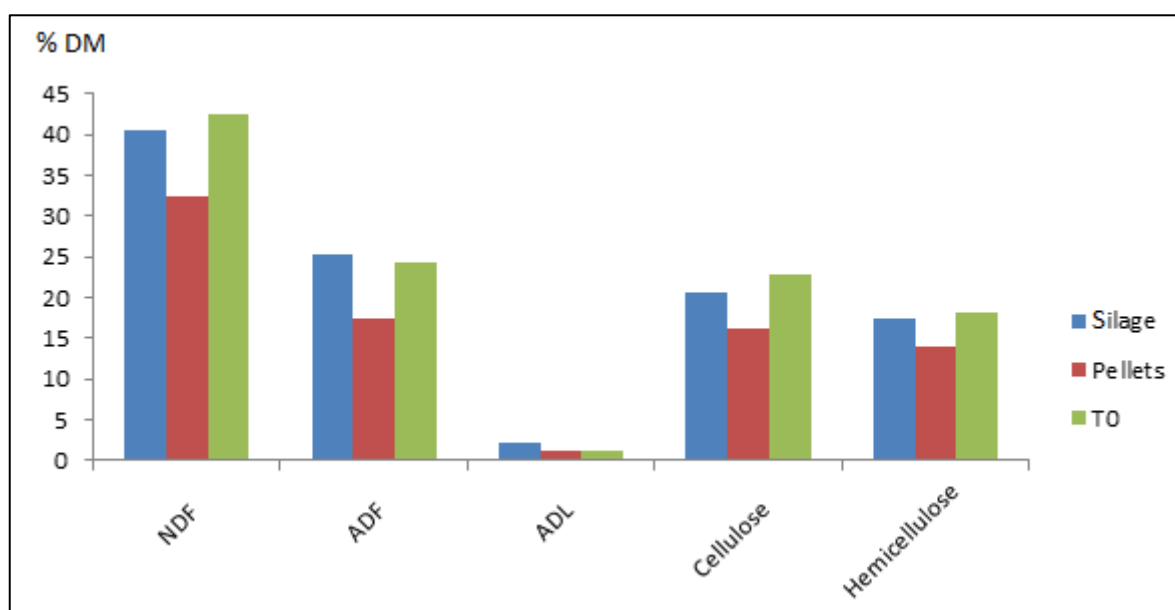

Figure 3.3. : Effect of the conservation technic (drying or silage) on the variation of the parietal components of the sugar beet pulp.

The diagram presented in the figure 3.3 shows us that the contents of ADF, NDF, ADL, cellulose and hemicellulose in the pulp preserved by silage (average of the silage at time T3, T6 and T12 in the bags of 50 kg) are approximate to the contents of pulp on the outlet side of the press (T0) and are higher than the contents of the pellets.

One can deduce that besides its fossil energy consumption, its cost high compared to the income of the farmer and its non-respect of the environment, the drying of pulp in the form of pellets can cause a reduction in the parietal components of pulp influencing its food value. However the silage makes it possible to maintain and preserve in better this value.

4. CONCLUSION

The silage is an effective method to preserve fodder with a minimum of nutritive loss in value but its fermentation can influence with a variable degree each component of fiber, it cause a drop in hemicellulose and the NDF and in against part made increase the ADF, ADL and cellulose compared to the initial values of the sugar beet pulp (on the outlet side of the press). But these small variations do not change large-thing in the food value of pulp since these values remain approximate to the values of pressed pulp. In addition, the drying of pulp in the form of pellets could cause a reduction in the parietal components of pulp influencing its food value.

ACKNOWLEDGMENT

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