4.6. TREATMENT OF CROP RESIDUES: A REVIEW

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INTRODUCTION

Straws and stovers have a low content of digestible organic matter, and they contain low levels of crude protein and essential minerals. The problem is caused by the fact that upon maturation of the crop, the cell contents are removed from the cell and the cell walls become thicker and woodier (# 3.3). Because of their high content of cell wall (= crude fibre), the straws have a particular value in diets with high levels of concentrate or succulent green feeds. When fed as a major part of the ration however, the low digestibility of the fibre is associated with the low intake of feed, and as a result, the intake of energy by the animal remains too low, even to provide sufficient nutrients to maintain the animal. Several ways can be employed to overcome this low feed quality, but the major ones are the addition of supplements in the ration (# 4.3) or the improvement of the straw quality itself, particularly by chemical and physical treatments. The principles and types of treatments are briefly described in this chapter, and the most important treatments will be elaborated in the following chapters.

Handbook for Straw Feeding Systems
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PRINCIPLES OF TREATMENTS

The basic principle of treatments is that they aim to break or solubilize the chemical and physical bonds in cell walls. This can be achieved by a variation of physical and chemical treatments that either use pressure, heat, chemicals or their combination. All that these treatments do is to "soften" the cell walls, i.e. they add no nutrients except for nitrogen in the case of ammonia treatment. This implies that, even after treatment, the feed still consists essentially only of cell wall. Though some of that cell wall may now be easier digestible, the feed essentially remains only cellulose and hemicellulose with variable quantities of lignin and minerals. It should also be obvious that plant material with relatively low cell wall contents, or highly digestible cell walls will benefit less from treatment. For this reason, maize, sorghum and millet stovers are less likely to show response to treatment than straws from rice and wheat. Also within wheat, rice and all other straws, the effect of treatment will be less pronounced in varieties that have a high initial digestibility, e.g. after a failed harvest, or in fine versus coarse rice straw (# 4.5).

Treatment improves rate and level of digestion, and thereby also the intake, but it does not make the bad feed into a good feed. The combined effect of increased digestibility and intake is shown in table 1 where improved digestibility alone increases the nutrient intake with about 17%. Improved intake alone increases the nutrient ingestion with about 24%, but the combined effect yields an increased nutrient intake of around 45%. With such a combined effect, the feed becomes good enough to allow nutrient intake above maintenance. One should keep in mind however, that treated straw will not become as good as feed, such as green fodder or concentrates. In other words, the production of milk and meat on treated straw alone will never be high and essentially that is true for all types of treated straw.

Table 1. The effect of urea treatment on digestibility, intake and on the intake of digestible dry matter and concentrate supplements.

Dry matter digestibility (%):	
Untreated straw	48
Treated straw	56
% increase	17
Dry matter intake (kg/100 kg BW):	
Untreated straw	2.1
Treated straw	2.6
% increase	24
Digestible dry matter intake (g/100 kg BW):	
Untreated straw	1.01
Treated straw	1.46
% increase	44

Source: Ibrahim, 1986.

The combined effect of increased intake and digestibility brings us to at least three other relevant observations:

- the measurement of digestibility at fixed intake levels explains only part of the treatment effect,
- in order to obtain maximum effects of straw treatments, it is important to have sufficient stock of straw to allow for the extra intake. A common complaint of farmers who try urea treatment is indeed that "the animals eat the straw better, but the straw is also finished sooner, and not enough -

straw remains to manage through the dry season".

- treatment of straw may result in savings on concentrate, though mainly because the animal can eat more straw.

The consequence of this all is a) that where straw is relatively expensive compared with concentrate, there is no point to replace the concentrate supplement with treated straws, b) by measuring only digestibility only a part of the effect is known, and c) treated straw is useful at medium levels of production, but it does not provide sufficient nutrients to serve as major feed resource for high producing animals.

Different crop residues respond differently to chemical or physical treatment. The action of alkali treatment is different in fibrous residues from monocotyledons (straws, mature grasses), than in residues from dicotyledons (tree leaves, legume straw). In fact, the effect of chemical treatment with alkali is well established in cereal straws, but there are reports that it would not work so well with legume straws. Also, the way in which cell walls are built up will affect the treatment result. Sugarcane is reported to have a higher crystalline structure of cellulose than straws, and heat treatment appears to be more effective on such residues.

TYPES OF TREATMENTS

The treatment of straw can be done in different ways, generally classified as chemical, physical and biological methods, or their combinations (Table 1.). Only the most relevant treatments are discussed in the following chapters, and their relevance is determined by the availability of technology, transport, power, access to other feeds and desired level of production.

Table 2. A classification of treatment methods (Source: adapted from Ibrahim, 1983).

Physical	Chemical	Physico-chemical	Biological
Soaking	Sodium hydroxide	Particle size/chemicals	Addition of enzymes
Grinding	Calcium hydroxide	NaOH/pelleting	White rot fungi
Pelleting	Potassium hydroxide	Urea/pelleting	Mushrooms
Boiling	Ammonium hydroxide	Lime/pelleting	
Steaming under pressure	Anhydrous ammonia	Chemicals/steaming	
Gamma irradiation	Urea/ammonia	NaOH/temp.	
Chlorine gas	Sodium carbonate		
Sulphur dioxide	Sodium chlorite		

The application of physical methods like steam treatment is obviously limited to industrial conditions where steam is available, typically the case for steam treatment of sugarcane bagasse. Other physical methods like chopping can employ machines or hand labour depending on the relative availability of labour, capital or other feeds (# 4.6.2). Densification is done with a different purpose in mind. Its main objective is to reduce the volume to economize on storage and transport (# 4.6.3).

Biological treatment, though tried under the BIOCON project, has not proven to be feasible in field conditions, due to a few fundamental and technical problems, leave alone the economics. Those problems include the identification of proper microbial strains, their survival in non sterile straw heaps, possible toxic effects of contaminant organisms and inevitable organic matter losses.

Chemical methods like sodium hydroxide (NaOH) treatments may be effective in a technical sense, but since the chemical is difficult to handle and not widely available there is no scope for its application under farmers conditions in India. The same is true for treatments with chemicals like hydrogen peroxide (H_2O_2), acids or strong alkalis like potassium hydroxide.

The most practical chemical treatment is urea treatment since urea is widely available and easy to handle. Even then, its economic applicability is limited, depending on the level of desired animal production, the relative availability of straws and other feeds, and the possibility to sell milk on the market. It is clear therefore that the applicability of each of these methods is limited to specific situations and seasons, i.e. large scale application of anyone of the methods is unlikely to take place. The treatments have specific feasibility under different feeding systems, as sensitively indicated in Table 3. The terms such as low and high, indicate that, for example in the top row, first column, under condition of low straw availability, chopping is relevant.

As an interesting sideline on the mechanics of physical and chemical treatments it can be said that physical treatment, e.g. the application of heat, can release organic acids that provide an additional chemical treatment. Also, chemical treatments can act as physical treatments where the ions attract water (hydration), producing a swelling action between the fibres.

Table 3. Applicability of treatments under different feeding systems.

Attributes	Treatments			
	Chopping (#4.6.2.)	Soaking (#4.6.2.)	Urea (#4.6.1.)	Steam
Availability of straw	Low	NA	High	High
Cost of straw	High	NA	Low	Low
Availability of labour	High	Med	Med	N.A.
Cost of labour	Low	Med	Med	N.A.
Initial straw quality	N.A.*	N.A.*	see text*	Low
Production level of animal	see text	see text	Low-Med	Low-Med
Availability of greens	see text	N.A.	Low	Low
Cost of concentrate	High	High	High	High
Cost of chemical	N.A.	N.A.	Low	N.A.

* provided not mouldy, here difference stovers/straws; NA: not applicable; Med: medium

CONCLUSION

Several treatment methods are available from the laboratory. Only very few, particularly urea ammonia treatment and chopping and/or soaking have relevance for field application, though each one for different reasons.

SUGGESTED READING

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