CROP RESIDUE TREATMENT: A TECHNIQUE FOR IMPROVING INTAKE AND DIGESTIBILITY OF RUMINANTS

Abdulazeez, A.
Federal College of Education (Technical) Gusau, Zamfara State, Nigeria
Corresponding author:azeezrazaq70@gmail.com, +2348028502373

ABSTRACT

This paper summarises the benefits of crop residues to ruminants, their shortcomings and how to overcome them. Factors affecting intake and digestibility of crop residues were reviewed and finally the processes of crop residue treatment using urea were also highlighted.

Key Words: Crop residue, Digestibility, Neutral detergent fibre, Nitrogen, Urea treatment

INTRODUCTION

Unlike developed nations where livestock farming is grain-based, developing African countries that are struggling to feed their teeming population cannot afford to feed livestock with grains (Abdulazeez *et al.*, 2021b). The available option however is to use crop residues which are by-products of cereals after harvest. The major disadvantage of these crop residues, however, is that they are low in nutritive values hence resulting in poor intake and digestibility (Abdulazeez *et al.*, 2021a). Several methods are being used in an attempt to improve the digestibility of crop residues and these include chemical, biological and physical methods. In other countries many chemicals have been used to improve digestibility of crop residues, but only few such as sodium hydroxide, ammonia and calcium hydroxide are common (Meng, 2002). When crop residues are treated with chemicals especially alkalis, hemicellulose are solubilized resulting in increase in rate and digestion of cellulose and hemicellulose (Jung and Allen, 1995). Chemical treatment also increases the palatability of crop residues. In biological treatment, crop residues are chopped into small particles then mixed with water and pressed. This is followed by introduction of additives such as lactobacillus and cellulolytic bacteria to aid fermentation and to preserve the nutrients (Jung and Allen, 1995). Given the variety of methods available, the choice of which methods depends on a host of factors such as availability of chemicals, safety, environmental conditions, level of mechanization (to chop and grind the stover) and capital. As for chemical methods employed in the treatment of crop residues, urea is more acceptable due to its safety and as a means of incorporating nitrogen (Church, 1991).

FACTORS AFFECTING INTAKE OF CROP RESIDUE: The rumen environment is said to be optimal when conditions such as mineral, S, N and pH for degradation of fibre are adequate. Optimum rumen conditions may not be attainable in some situations due to presence of anti nutritional factors in feeds ingested. These anti nutritional factors prevent rumen microbes from degrading the ingested and accompanying feed and may even cause problems to the animal (Orskov, 1995). Several factors affecting intake of crop residues include: (a) rumen fill and passage (b) fibre level.

RUMEN FILL AND PASSAGE: The characteristics of roughage that affect rumen fill and passage are: the soluble fraction ‘a’, insoluble but fermentable fraction ‘b’ and degradation rate ‘c’ (Orskov, 1995; Jung and Allen, 1995). According to Orskov (1995), when hay is left in rain, most of the soluble substances in the cells would be washed off leading to reductions in both intake and digestibility. The cells’ soluble substances occupy little space in the rumen and are made up of soluble carbohydrates and proteins that are rapidly fermented in the rumen. Soluble materials can be estimated either by washing the roughage with water over a particular period of time followed by determination of the dry matter loss or estimated as the material that is soluble in neutral detergent solution. Soluble materials can also be determined by washing samples in nylon bag in water followed by determination of the dry matter loss (Orskov, 1995; Chenost*et* *al*., 1995).The 'b' fraction is determined using the degradation characteristics of insoluble material by extrapolating the exponential curve to the asymptote. Differences in degradation rate and retention time make the achievement of the asymptote rare (Blummel and Orskov, 1993; Orskov, 1995) therefore the fraction that is totally not digestible would require longer residence time and space in the rumen before being passed out as faeces. Orskov (1995) and Khazaal (1996) reported that what determines the quality of 'b' fraction is the rate at which it is fermented in the rumen. The rate of the degradation therefore determines the residence time and passage. When rate of degradation is faster then, the passage rate also is increased.

FIBRE DIGESTIBILITY AND INTAKE: The filling properties of feed is dictated by how fibrous a feed is, since more fibrous feed degrades and passes from the reticulorumen more slowly than the non fibrous feed (Jung and Allen, 1995). According to Van Soest (1994), neutral detergent fibre (NDF) and acid detergent fibre (ADF) are negatively related to voluntary dry matter intake (VDMI) in sheep fed forage diet and that NDF is more related to VDMI than ADF in both legumes and grasses. Jung and Allen (1995) reported that higher VDMI would increase in ruminants consuming forages with low NDF content. The NDF content of forage has been reported as the best chemical predictor of VDMI (Waldo, 1986). Jung and Allen (1995) attributed two factors to the unexplained variation in NDF in which forage diets were fed. 1) The effect of NDF was not completely described by the filling effect of feed and VDMI of animals was not confined to physical fill. 2) The amount of space that is occupied with time in the reticulorumen and initial bulk density of the feed determines size of fill. Fahey and Merchen (1987) reported that physical method of processing or chemical treatment as well as differences in NDF constituents of different feeds make these factors to vary.

TREATMENT OF CROP RESIDUES:There are various methods employed in the treatment of straws, some of these methods include mechanical means such as grinding, physical such as heat and pressure treatments and chemical treatment that involves use of popular chemicals such as sodium hydroxide and ammonia (Greenhalgh, 1984). Historically, the use of chemicals to treat crop residue started in Germany in 1920 when sodium hydroxide was used to improve digestibility. The mode of action of the chemicals used in the treatment of crop residue involves breaking of bonds linking hemicellulose and lignin making it possible for rumen microbes to act on the hemicellulose. Most of the chemicals used for the treatment of roughages include sodium hydroxide, sodium sulphate, sodium bicarbonate, ammonium hydroxide, calcium hydroxide, potassium hydroxide and ammonia (Sundstol *et al*., 1978). Out of all the chemicals listed, NaOH is more effective in improving digestibility of roughage however it is deficient in nitrogen with low availability, costly and pollutes the environment (Sundstol *et al*., 1978). Chenost (1995) reported that urea treatment is now the best method suitable for use by smallholder farmers in the tropics. Sundstol and Coxworth (1984) reported that treatments of crop residues with urea does not pose handling risk and is easy to transport.

Ammoniation has been reported to increase digestibility, nitrogen content and voluntary intake by 5-10%, 1-2% and 50% respectively (Preston, 1985). Reports from FAO (2002) also showed that ammoniation increases CP and decreases NDF and ADL contents of crop residues. The increase in CP and decrease in both NDF and ADL indicated that ammoniation is an effective treatment tool. Significant improvement in intake of urea-treated compared to untreated rice straw had been reported by Fall *et al*. (1989). Ammoniation involves two processes; the first process known as ureolysis involves conversion of urea to ammonia while the second process uses the ammonia generated to weaken the bonds in the cell walls of crop residue being treated (Chenost, 1995). Ammoniation breaks the bonds between lignin and cellulose thereby creating an enabling environment for rumen microbes to act on.

UREA TREATMENT PROCESS: Urea treatment of crop residue varies from one place to the other and depends on many factors such as weather condition. The general process however involves dissolving 4-

5% urea in 0.2-1 liter per kg crop residue (Chenost, 1995). According to Sundstol and Coxworth (1984) crop residue treatment can be carried out in pits lined with plastics. The lining of the pits with plastics is aimed at eliminating air; however, other locally available materials such as jute bags and banana leaves can be used. Duration of treatment varies from one week to eight weeks in warm and cold conditions respectively (Chenost, 1995). In Africa where the temperature is always warm, treatment duration ranges from 7-15 days (Sundstol*et al*., 1978). According to Chenost (1995), several factors affect treatment of crop residue with urea; these factors include presence of urease , moisture content, ambient temperature, period of treatment, application rate, type and quality crop residues.

PRESENCE OF UREASE; Urease is the enzyme produced by the ureolytic bacteria and its presence in crop residue to be treated brings about conversion of urea to ammonia (Sundstol and Coxworth, 1984). When crop residues are deficient in urease, soya bean which is a natural source of urease can be added. Chenost (1995) reported that some bacteria called ureolytic bacteria also produce urease when there is enough moisture during crop residue treatment. Since rural farmers cannot determine presence of urease physically in crop residue, it is advisable to spread some soya bean as source of urease in order to forestall treatment failures that may arise from lack of urease.

MOISTURE CONTENT: In crop residue treatment, final moisture content must be considered paramount for a successful result. According to Chenost (1995), 30-60% of moisture is required for ammoniation and ureolysis, so when the moisture content is below 30% ureolysis is reduced hence affecting the process of ammoniation. Sundstol*et al.* (1978) reported positive effect on *in vitro* organic matter digestibility when moisture content regardless of temperature was increased from 12 to 50%. However there was no positive effect when the moisture level went below 3.3%. From all indications the amount of water to be used during treatment is dependent on weather conditions and moisture content of crop residue to be treated for effective ureolysis.

TEMPERATURE AND TREATMENT DURATION: The range of temperature needed for ureolysis is 30 – 60 ^{0}C and it is completed between 1 – 7 days however when temperature drops below 5 - 10 ^{0}C, urease activity is reduced or stopped. Sundstol*et al.* (1978) reported that in order to nullify the effect of low temperature, treatment time should be extended. Effective treatment of crop residue is achieved between 17-25 ^{0} C within four weeks but when treatment is carried out under low temperature the duration lasts up to eight weeks. Since ureolysis is very effective under higher ambient temperature, then ammoniation would be more efficient in the tropics where temperature is always higher than in the temperate regions with low temperature.

APPLICATION RATES: When straws are treated with urea above 4% there is no improvement in their digestibility however a satisfactory result had been recorded in Asia and Africa with 5% urea (Sundstol*et al*., 1978; Chenost, 1995).

CONCLUSION

Treatment of crop residue using urea that is abundantly available is recommended to livestock farmers in order to improve their intake and digestibility.

REFERENCES

Abdulazeez, A., Madibela, O.R., Tsopito, C.M. (2021)a. Effect of substituting corn with cobs treated with combinations of urea and wood ash on chemical composition and ın vitro gas production substrate, Journal of Animal Science and Products (JASP) 4 (1):85-95. DOI: 10.51970/jasp.914984

Abdulazeez, A., Tsopito, C.M., Madibela, O.R. (2021)b. Chemical composition and gas production substrates of maize cobs treated with combinations of urea and wood ash, Journal of Animal Science and Products (JASP) 4 (1):73-84. DOI: 10.51970/jasp.879558

Allen, M. S. (1996). Physical constraints on voluntary intake of forages by ruminants. *Journal of Animal Science* 74: 3063-3075.

Blummel, M., Orskov, E.R. 1993. Comparison of *in vitro* gas production and nylon bag degradability of roughages in predicting of food intake in cattle. *Animal Feed Science and Technology* 40: 109-119.

Chenost, M. (1995). Optimizing the use of poor quality roughage through treatments and supplementation in warm climate countries with particular emphasis on urea treatment. first electronic conference on tropical feeds with particular emphasis on urea treatment FAO, Rome.

Chenost, M., Deverre, F., Aufrere, J., Demarquilly, C. (1997). The use of gas-test technique for predicting the feeding value forage plants. In: *In vitro* techniques for measuring nutrient supply to ruminants. Proceedings of Occasional Meeting of the British Society of Animal Science, 8–10 July 1997, University of Readings, UK.

Church, D.C., (1991). Livestock Feeds and Feedings. (3rd Ed) Prentice - Hall International Edition, USA.

Fahey, G.C., Jr. Merchen, N.R. (1987). Analytical procedures associated with estimation of feed intake: The detergent system of analysis. In: Owens, F.N., (Ed.), Proc. Symp. Feed Intake by Beef Cattle. p 41.Oklahoma State Lhiv. Agric. Exp. Sta., Stillwater.

Fall, S., Guerin, H., Sall, C., Mbaye, N.D. (1989). Cereal straws in the feeding system of ruminant in Senegal. Overcoming constraints to the efficient utilization of agricultural byproducts as animal feed In: Adegabola, A. A., Kategile, J.A., Little. D.A., (eds.), Proceedings of the Fourth Annual Workshop Held at the Institute of Animal ResearchMankon Station African Research Network for Agricultural Byproducts (ARNAB), Addis Ababa, Ethiopia.

FAO, (Food and Agriculture Organization of the United Nations) (2002). Animal Production Based on Crop Residues; China's Experiences. FAO Animal Production and Health Paper No. 149. pp39.

Greenhalgh, J.F.D. (1984). Upgrading crop and agricultural by products for animal production. In: Gilchrist F.M.C., Mackie R.I., (eds.), *Herbivore Nutrition in the Subtropics and Tropics*. The Science Press, Pretoria, South Africa pp167 - 184.

Jung, H.G., Allen, M.S. (1995). Characteristics of plant cell walls affecting intake and digestibility of forages by ruminants. *Journal of Animal Science* 73: 2274-2290.

Khazaal, K., Parissi, Z., Tsiouvaras, C., Nastis, A., Orskov, E.R. (1996). Assessment of phenolic-related anti nutritive levels using *in vitro* gas production technique: a comparison between different types of polyvinylpolypyrrolidone or polyethylene glycol. *Journal Science Food and Agriculture* 71: 405-414.

Meng, X. (2002). Animal Production Based on Crop Residue – Chinese Experiences. FAO Animal Production and Health Paper149, FAO Rome.

Orskov, E.R., 1995. Plant factors limiting roughage intake in ruminants. In: Speedy, A.W., Dalibard, C., Sansoucy, R. (Eds.), Tropical Feeds and Feeding Systems, Proceedings of the FirstFAOElectronic Conference on Feed Evaluation. FAO, Rome Tropical Feeds and Feeding Systems http://www.fao.org/livestock/agap/frg/ECONF95/PDF/EVALU.PDF accessed July,2015.

Preston, T.R. (1985). Strategies for Optimizing the Utilization of Crop Residues and Agro industrial By-products for Livestock Feeding in Tropics. Towards Optimal of Agricultural By-products to Livestock in Africa. Proceedings of a Workshop held at the University of Alexandria. International Livestock Center for Africa (ILCA), Egypt pp17.

Sundstøl, F., Coxworth, E., Mowat, D.N., 1978. Improving the Nutritive Value of wheat Straw & other low quality roughages by treatment with ammonia. *World Animal Review*, 26:13-21.

Sundstol, F., Coxworth, E.M., 1984. Ammonia treatment In: Sundstol, F., Owen, E., (Ed.), Straw and other fibrous by-products as feed, Elsevier, Amsterdam, pp 196-247.

Van Soest, P. J., (1994). Nutritional Ecology of the Ruminant. 2nd ed. Cornell Univ. Press, Ithaca, NY.

Waldo, D.R. (1986). Effect of forage quality on intake and forage concentrate interactions. *Journal of Dairy Science*. 69 (2): 617-631.