THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
February 2024 Vol.4(2), 741-745

Popular Article

Biological Methods of Feed Processing

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https://doi.org/10.5281/zenodo.10689226

Abstract

Livestock owners in tropical countries like India rely heavily on fibrous crop residues and non-conventional dry roughages as feed for their animals. These feed sources, characterized by high lignocellulosic content, low nitrogen, and minerals, present challenges for efficient digestion by rumen microbiota due to the presence of lignin, which acts as a barrier to microbial breakdown. To improve the feeding value of these low-quality roughages, various physical and chemical processing methods have been explored which have their own limitations and few are environment unfriendly. The biological treatments of crop residues to improve the accessibility of cellulosic fractions, thus improving their digestibility and feeding value have been employed. Various biological treatment i.e., enzyme treatment, fermentation, treatment with fungi, karnal process, zadrazil Process have been utilize for better utilization of low-quality feed. Despite certain limitations and organic matter losses associated with these biological treatments, ongoing research seeks to optimize these methods for sustainable and efficient utilization of crop residues as livestock feed.
Keyword: Biological treatment, digestibility, feeding value, fibrous crop

Introduction

Livestock owners in tropical countries like India depend on fibrous crop residues like wheat straw, paddy straw, finger millet straw and barley straw and stovers (kadbi) of sorghum, pearl millet and maize etc. and non-conventional dry roughages: sugar cane trash, baggase and fallen tree leaves etc. They are low density feeds and are often referred to as 'lignocellulosics' characterized by large content of structural carbohydrates (cellulose and hemicellulose), low level of starch type carbohydrates, low nitrogen and minerals and varying amounts of lignin, which rendered them to be classified under non-maintenance type of feeds. Cellulose and hemicellulose in crop residues are in complex form with biopolymer lignin. Rumen microbiota (bacteria, protozoa and fungi), even with their hydrolytic enzymes, are not very competent enough to break these bonds efficiently. The extent to which cellulose and hemicellulose are digested in the rumen depends on the degree of their association with each other and lignin. It has been suggested that lignin acts as a physical barrier and impedes microbial breakdown of these materials (Owen, 2013). The usefulness of cellulose depends on the extent and rate at which it can be degraded by rumen microorganisms. High quality roughage is usually low in lignin and high in protein and is highly digestible. Low quality roughages are usually low in protein, high in lignin and are poorly digestible.

Therefore, various physical and chemical processing methods have been tried, which are known to improve feed quality either by increasing digestibility or by enhancing palatability. However, these treatments have their own limitations and few are environment unfriendly. The biological treatments of crop residues to improve the accessibility of cellulosic fractions, thus improving their digestibility and feeding value have been employed.

Biological methods of feed processing

Biological treatments involve the living organisms specially microbes (Fungi) and enzymes to improve the nutritive value of poor-quality roughages (Ajila et al., 2012). Microbes can break the ligno-cellulose complexes with enzyme secretions and liberates free cellulose and thus enhancing crop residues feeding value for ruminants. Biologically treated roughages have higher digestibility for most of the nutrients (both cell walls and cell solubles) with an increase in crude protein content as compared to untreated material, besides ensuring more fermentable substrates in the rumen. The ideal microorganisms for biological treatment should have strong lignin metabolism with low or no affinity towards cellulose and hemicelluloses.

Biological Feed Processing methods:

1) Enzyme treatment
2) Fermentation
3) Treatment with Fungi
4) Karnal Process
5) Zadrazil Process

1) Enzyme treatment

Animals uses enzymes in digestion of feed, those produces either by animal itself or by microbes present in digestive tract. Enzymes that attack lignocellulolytic bonds in crop residues

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Published 21.02.2024

for enhancing their feeding value has been attractive. Cellulase solution is sprayed on straw at 25 mg/100kg straw. Wang (1998) treated maize stover with an enzyme prepared from *Trichoderma viridae*, reduced the contents of small cell wall components and enhanced the ruminal digestibility in sheep. Abd- Galil treated sugarcane bagasse with cellulase enzyme which improved its chemical composition, nutrient digestibility, average daily gain, feed intake and feed efficiency.

2) Fermentation

Chopped straw is pretreated with 3-5% NaOH, and steamed at 120°C for 15 min; then fermented with bran type media cultured with cellulolytic microorganisms at 40- 50°C for 2 days.

3) Fungal treatment

Ligninolytic microorganisms are mainly wood inhabiting fungi. They are able to colonize different plant residues and increase the digestibility of the substrate. Following three majors aerobic ligninolytic fungi are known to play a major role in lignin degradation of straw.

a) Soft-rot fungi

These fungi leave the attacked lignocellulosic material watery-soft and breaks down cellulose and hemicelluloses. *Chaetomium cellulolyticum.*

b) Brown-rot fungi

These fungi preferentially attack cellulose and hemicellulose, leaving lignin intact, thus, decaying residue turning brown. Brown rot fungi are mainly humifiers causing only limited changes in lignin. *Agrocybeaegerita and Flammulina velutipes.*

c) White-rot fungi

These fungi are capable of degrading lignin without affecting much of cellulose and hemicelluloses thus causing decayed residue to turn white. WRF attack unaltered lignin polymers causing cleavage of inter lignol bonds and aromatic ring cleavage. They mainly degrade polysaccharides by hydrolytic enzymes like cellulases and xylanases, and lignin by oxidative ligninolytic enzymes such as lignin peroxidase (LiP), manganese peroxidase (MnP) and laccase. *Abortiporus biennis, Agaricus bisporus, Dichomitus squalens, Pleurotus eryngii, Pleurotus sajor-caju, Pleurotus ostreatus, Pleurotus flabellatus, Pleurotus floridanus, Phanerochaete chrysosporium, Ganoderma sp.* rckk02, *Crinipellis sp., Pycnoporous sangeus, Coriolus versicolor, Lenzites striata, Poria plascenta, etc*

Some of the white-rot fungi like *Phanerochaete chrysosporium* degrade lignin to the extent of 65-75% while other fungi like *Ganoderma applanatum and Coriolus versicolor* degrade over

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Published 21.02.2024

45% of lignin in the lignocellulosic materials.

Preference is given to species which degrade only lignin but not hemicelluloses.

4) Zadrazil process

Straw was treated with *Pleurotus sp.* The process has enormous losses of organic matter. It is unfit for small level operations at farmer's level.

5) Karnal process

It is essentially a biological treatment of ligno-cellulosics in solid substrate fermentation (SSF) system under non sterile conditions which causes a promising improvement in the enhancement of quality of straw.

It is a two-stage process:

First stage: In this stage Cereal straws are pretreated with 4% urea and 40% moisture and ensiled for 30 days. Urea breaks the ligno-carbohydrate bonds in the treated straw. Besides breaking bonds, produces ammonia which helps in creating conducive environment (high pH), increases CP content from 3-4% to 12-14% and acts as a chemical sterilent in preventing the growth of unwanted organisms.

Second stage: urea treated material is mixed thoroughly with 1% single superphosphate, 0.1% calcium oxide and then moisturize to 60-65% before inoculation with 3% *Coprinus fimetarius* (alkalitolerant strain) culture grown on millets. The solid substrate fermentation was terminated at mycelial stage of growth of *C. fimetarius.* The fungus traps the excess free ammonia in the urea treated straw and synthesize amino acids. Thus, there was substantial increase in the amino acid content of fungal treated straw. Considerable dry matter losses were there. However, dry matter losses were reduced from 35% to 7% by applying certain modifications.

Conclusion

Biological processing methods offer promising tool for improving the feeding value of fibrous crop residues and non-conventional roughages for livestock in tropical regions. Enzyme treatments, fermentation, and fungal treatments show potential for breaking down lignocellulosic bonds and increasing digestibility. The Karnal process, with its two-stage fermentation approach, stands out for its effectiveness in enhancing straw-based feed quality. Further research is needed to optimize these methods for widespread adoption, ensuring sustainable livestock nutrition in tropical agricultural systems.

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Published 21.02.2024

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Published 21.02.2024