Studies for improving the nutritive value of poor quality roughage through biological treatments

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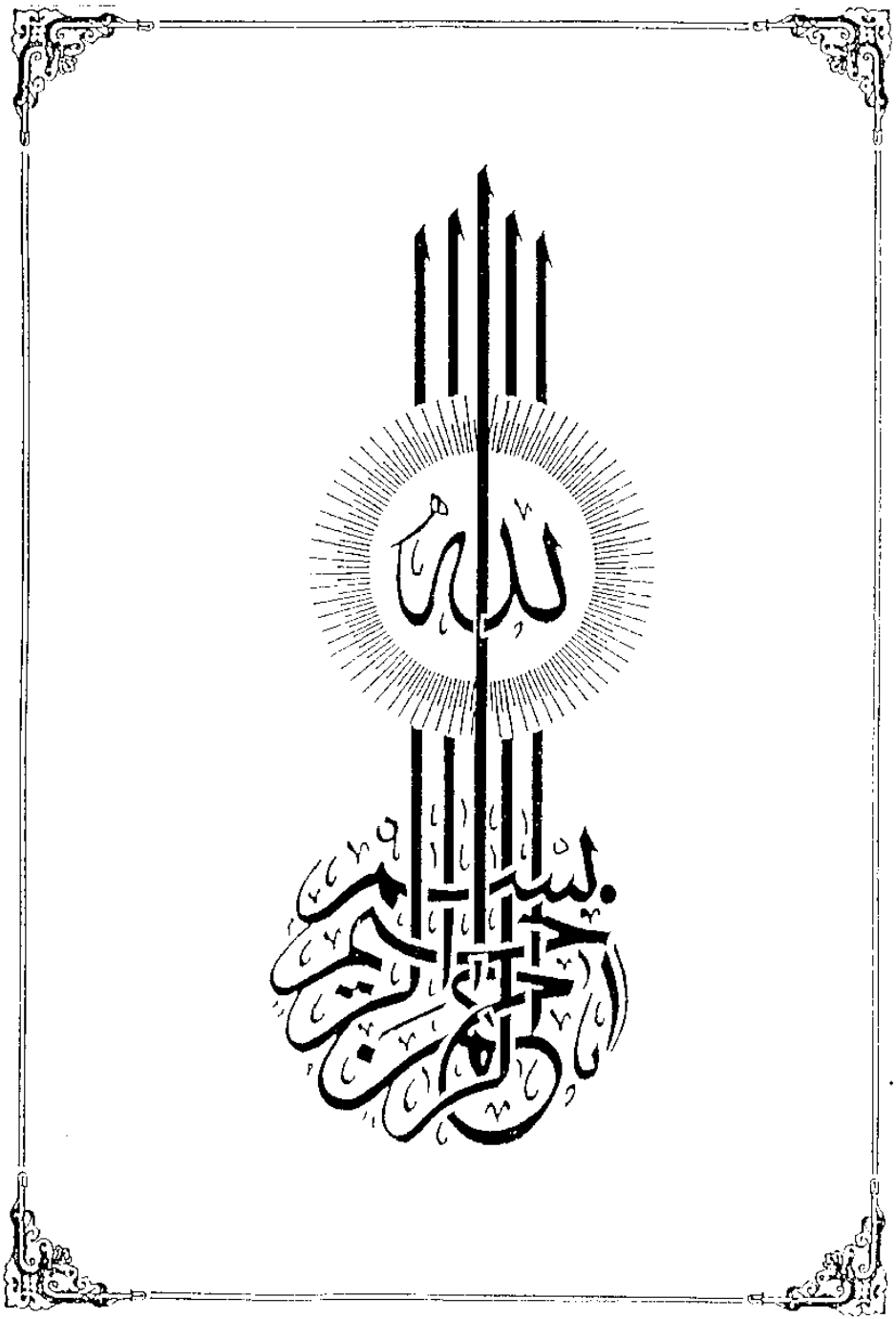
INTRODUCTION



1. INTRODUCTION

A potentially serious problem in Egypt is the extreme shortage in animal feeds. Such a problem appears to be growing rather than diminishing in magnitude or even stabilizing. Conventional feeds are not entirely satisfactory because of their considerable high prices.

Therefore, there is an important need to search for more available and cheaper roughage particularly agricultural by- products. Improving the utilization of these residues and improving the nutritive value of such residues would provide a major contribution in the field of food security.

In Egypt, there are about 12 million tons of plant by-products; rice straw, wheat straw, bean straw, corn stalks and stoker corn cobs, cotton stalks, rice hulls and sugarcan bagasse (Hathout, 1984). These lignocellulosic materials are characterized by having a poor nutritive value (an extremely, low, protein, energy, minerals, and vitamins content), Lower digestibility, lower feed intake and a high percentage of crude fiber.

Good extension is required to apply the well established methods of improving the poor quality roughage and their proper use of feeding animals.

It is now well established that the nutritive value of lignocellulosic wastes could be improved substantially by different methods of physical, chemical and microbiological treatments.

The nutritional quality of lignocellulosic by- products could be increased by microbial treatment and increase digestibility the lignocellulose in ruminants. Also protein content could be elevated. Improvement in dry roughage palatability and dry matter intake was noticed.

Higher fungi mushroom,more than 2000 species, are known to be edible. Of those, fewer than 25 species are widely accepted as food. Higher fungi could utilize the plant west material. The spent produced as waste from mushroom cultivating could be used as animal feed (Zadrazil,F. 1973)

The aim of this study is to investigate the effect of biological treatment on the chemical compostion, cell wall constiteunts, in vitro fermentation, and the nutritive value of the plant waste material. Also, Studying the effect of using different levels of spent wheat straw in the sheep diet.

REVIEW OF LITERATURE

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2.1. Utilization of crop residue:-

Most of plants grown on farms with the purpose of production of commodities, yield considerable amounts of crop by-products, which are not consumed by man. Such by-products usually contain quite high amounts of fibrous substances. Thus with increasing commodity yields, there will be increasing in the amounts of crop residues, available also for livestock as feed.

In Egypt, more than 12 million tons of crop residues, from which only about 4 million tons, consisting of wheat straw, rice straw and other straws, are available at present as feeds for livestock. However, the great majority (more than 8 million tons) is still wasted or burnt. According to Hathout (1984) the approximate amounts of crop residues, that are produced annually in Egypt can be listed as follows:

Corp residue	**Approximate amount produced (million tons per year)**
Wheat straw	2.94
Rice straw	1.15
Miscellaneous straw	0.75
Maize stalks	3.50
Sorghum stalks	1.20

Various stalks other than cotton	0.10
Corn cobs	0.60
Rice bran	1.00
Sugar-can bagasse	1.00

2.2. Composition and polysaccharide structure of crop residues:-

Lignocellulosic cell wall material consists of cellulose, hemicellulose and lignin (In the ratio of 4:3:3) as main components, and a high content of ash, and low content of protein and stored carbohydrates (Han and Ciegler, 1982 and Theander and Aman, 1984).

However, Millet and Baker (1975) and Schurz (1977) found that, the lignin-cellulose-hemicellulose combination provide the mechanical strength for plant and contribute resistance for fiber against chemical, enzymatic and/or microbial attach. Schurz (1977), added that ,this resistance apparently stems from the close physical and chemical association between cellulose and lignin, increased by the crystallin nature of cellulose itself .

Chang, S.T. (1987), also found that, lignocellulose is a complex insoluble molecule made up of aromatic building blocks resistant to break down. This complex consists of three main components with varying proportions:-

1- Cellulose:-

Which its chemical composition is simply but physically is complexes, consists of β-1,4 liked glucose polymers;

2- Hemicellulose:-

Which contains complex polymers of different pentoses and hexoses.

3- Lignin:-

Which is more or less a random polymerization from a limited number of different phenolic compounds.

Inaddition the interrelationships between the cell wall constituents must have a great influence on the biodegradability of plant cell walls (Theander and Aman, 1980).

On the other hand, acetyl groups, phenolic acid monomers (Ferulic acid and P. coumaric acid), cutin, suberin and some metal cations have been shown to be bound or complexes with cell wall polymers. (Hartley et al., 1976; Jones, 1978; Bacon et al., 1981 and Nimz et al., 1981).

The ligno-cellulosic materials can be treated with various chemical or biochemical methods (Cross et. al., 1974, and Mcleod & Minson ,1974), which bring the consider-

able chemical and microbial resistance as well as low digestibility of ligno-cellulose.

Moreover Steven et. al., (1978), reported that ligno-cellulosic crop residues are deficient in the essential amino acids; threonine, lysine, tryptophane and methionine.

Nevertheless, the digestibility of lignocellulosic materials can indeed be modified by a variety of physical, chemical, microbial treatments and/or combination of these methods. Bearing in mind from the economic point of view, most treatments have energy requirements, that depend on the severity of the process.

2.3. Biological Treatments:-

Higher fungi mushroom have been used as human food. More than 45,000 species of Fungi technically described two thousand species are known to be edible of these. Fewer than 25 species are widely accepted as food and only about 10 have became commercial items. In nature many fungi grow on living or dead parts of plants, which are generally poor in nutrients and vitamins for both mycelium growth and fruit body development. They could be also grown on ligninocellulose material such as corn cobs, all grain straws, paper, wood shavings, sawdust nut shells and vegetable wastes, as well as food industry wastes and banana leaves (Zadrzil,1973).

2.3.1. Fungal growth on solid substrate:-

Weiland, (1988) stated that, the filamentous fungi grow on solid surfaces as roots in the soil. But the tubular body of the fungal filament grows along side the solid particle, using the available surface liquid film as a source of moisture and nutrients. In the case of lignin degrading fungi the growing tips of the filament produce powerful extracellular lignin degrading enzymes. Which act as a "chemical drill" for penetrating the substrate and for converting lignin to metabolic products. The mycelial mat fills the space between the solid particles, but since there is no free liquid and hence nutrient in this interstitial space, growth rate depend on the ability of the mycelial mat to reach the next available substrate, (FIG.1).

2.3.2. Enzymatic degradation of lignocellultic system:-

White-rot fungi and related basidiomycetes fungi are probably the most efficient terrestrial microorganisms capable of utilizing all of the polymers of lignocellulosic residue, which is not available for fungal growth in their macromolecular form, (Kirke, 1983). Wood, (1985), reported that, a range of both hydrolytic and oxidizing enzymes are excreted into the lignocellulosic substrate. acting to polmerise (the lignocellulose polymers) into compounds of lower molecular weight which can be assimilated by the fungus.

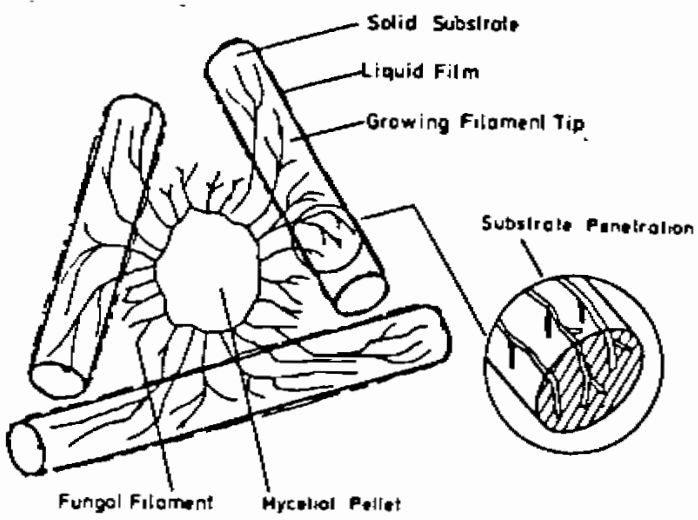

Fig.1 : Fungal growth on solid Substrate

Ref . Weiland, P . (1988)

Kirk, (1975) added that, whit-rot fungi decompose wood by converting the lignin eventually to CO_2 and H_2O.

The whit-rot fungi, basidiomycetes type, are capable of producing a range of lignocellulolytic enzymes when grown on various suitable media (Paice, et. al., 1978; Eriksson, 1981; Priest, 1983; Coughlan, 1985; Leatham, 1985 and Wood, 1985).

2.3.2.1. Cellulolytic enzyme:-

Eriksson (1978), showed the enzyme mechanisms involved in cellulose and lignin degradation by white-rot fungi **(Sporotrichum Pulverulentum)**. The enzymatic mechanisms for cellulose degradation and their extracellular regulation in **S.Pulverulentum** are shown in figure (2). Enzymes involved in cellulose degradation are (1), endo 1,4 β. glucanases; (2), exo 1,4-β- glucanase; (3), glucosidase; (4), glucose oxidase; (5), cellobiose oxidase; (6), cellobiose: quinone oxidoreductase, catalase enzyme; involved in lignin degradation; (A), laccase; (B), peroxidase. An asterisk dentoses products regulating enzyme activity; gluconolactone inhibits (3); cellobiose increases trans glycosylations.

2.3.2.2. Ligninolytic enzyme:-

Clenn et. al., (1983) and Tien & Kirk (1983), the discovery of lignin-degrading enzyme was proceeded by a study of a $C_\alpha - C_\beta$ cleavage reaction in a dimeric lignin

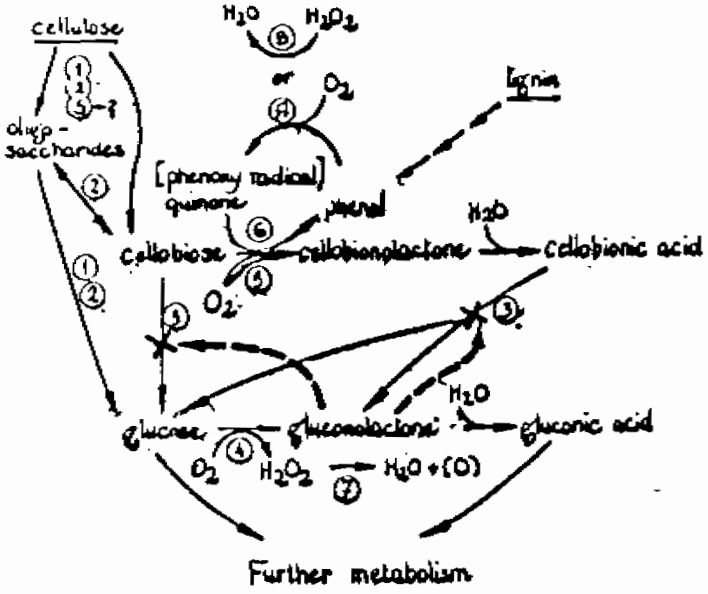

Fig. 2 Enzyme mechanisms for cellulose degradation and their extracellular regulation in S. pulverulentum.

Ref. Eriksson, K.E. (1978)

Model by ligninolytic cultures. Where as it was found that, the enzyme depolymerize methylated birch wood lignin in the presence of H_2O_2. The enzyme ,lignolitical enzyme, was identified as a peroxidase (Harvey et. al., 1985; Kuila et. al., 1985).

Clenn. et. al.,(1983), cited all of the compounds which have been shown to be degraded by **Phaneorochaete Chrysosporium** cultures grown under ligninolytic conditions. Both diarylpropane and diarylethane are rapidly cleavage at their respective C_α, $C_\beta$bounds.

diarylpropane ----------> diethoxybenzaldehyd + phenylglucol + phenylketol

diarylethane ----------> diethoxybenzaldehyd + anisylalcohol + ansiylaldehyde

B-ether dimer ----------> benzaldehyde + phenylglucerol

Olifen ----------> diol + benzaldehyde.

These results indicate that, this enzyme preparation is at least partially responsible for the oxidative cleavage reaction carried out by intact cultures. The result with enzymic degradation of ^{14}C ring labeled lignin also indicate