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Wheat Straw: A Pragmatic Overview

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Abstract: Wheat Straw (WS) is the agricultural by-product obtained from different parts of wheat plant like stem, leaves etc. The aim of the study is to highlight the important aspects and features of nutritional value of wheat straw and to summarize the economical and commercial values of this treasure produced abundantly in Pakistan. WS is rich in cellulosic fibers, hemicelluloses, proteins, lignin and ash. All these elements together make WS as most important and balanced substrate for microbial cultures for its diverse applications in fermentation, food, feed, medicine industries and in fields to increase soil fertility. In fermentation industry, WS can be used as a substrate for the production of vast range of hydrolytic enzymes, medicines, biofuel and other metabolites. It is the cheapest or low cost source of natural substrate.

Keywords: Agricultural by-products, biochar, bioremediation, chemical composition, fermentation, soil fertility

INTRODUCTION

Grasses, trimmings of lawns, other agriculture wastes, industrial, domestic, food and urban solid wastes are produced at a rate of 43 million tons/year. Utilization by recycling of these wastes would not only aid in pollution abatement but can also serve as a vital source of energy and food for the future (Rajoka, 2005). These waste products containing lignocelluloses' biomass are the most abundant organic raw material and are being used widely in fermentation industry as a microbial substrate for the production of many value added products including hydrolytic enzymes (Reith *et al*., 2002; Singh *et al*., 2006).

Pakistan is an agricultural country and wheat is one of the most important crops. It has been estimated that worldwide consumption of wheat has been found to be 652.18 million ton for year 2010 (WASDE, 2010). Wheat straw is a by-product, the dry stalk of wheat (Fig. 1) after the grain and chaff have been removed (Gubitz *et al*., 1998; Bajpai, 1999; Singh *et al*., 2009). It is usually gathered and stored in a straw bale and has many uses. The better utilization of WS will not only support the medicine, cosmetics, soil fertility, bio charcoal, fuel, livestock bedding and fodder, basket-making and fermentation industry. It can also be a source of an additional income for the farmers. This can be an important motivational factor in promoting an efficient harvesting, collection and management of WS (Yasin *et al*., 2010). This study reviews various applications of wheat straw in the fields of fermentation, study and pulp industry, medicine, bioremediation and soil fertility etc.

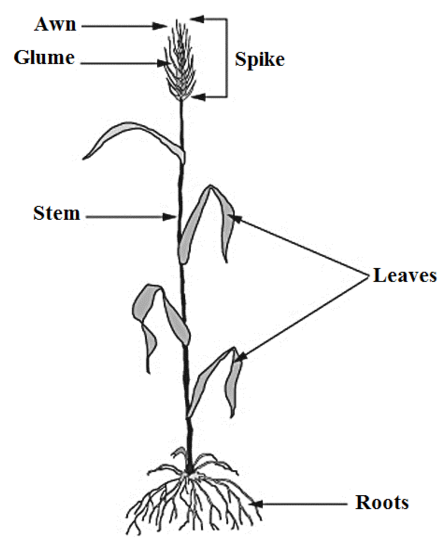

Fig. 1: Morphology of wheat plant showing spike (head)

CHEMICAL COMPOSITION OF WHEAT STRAW

Wheat straw is primarily composed of cellulose, hemicellulose and lignin. The main fractions of WS are (Fig. 1); nodes, internodes and leaves (McKean and Jacobs, 1997). Chemical analysis of WS shows that it is rich in carbohyderates (cellulose, hemicellulose, lignin), proteins, minerals (calcium and phosphorous), silica, acid detergent fibres and ash (Table 1). Along with these components, WS is also rich in bioactive compounds and vitamins (Slavin, 2003). However the

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Table 1: Chemical composition of wheat straw (Ali *et al*., 1991; Patterson, 1995; Yasin *et al*., 2010)

Components	Percentage (%)
Dry matter	89 to 94
Metabolizable energy mcal/*lb*	0.67
Crude protein	3.6
Acid detergent fibre	54
Cellulose	33.7 to 40
Hemicellulose	21 to 26
Lignin	11 to 22.9
Ash	7 to 9.9
Silica and silicates	4.5 to 5.5
Calcium	0.18
Phosphorus	0.05
Relative feed value	60

accurate composition of macro and micronutrients can vary from cultivar to cultivar (Safdar *et al*., 2009), stages of plant growth, the nature of soil and fertilizer to be used and climatic conditions (Yasin *et al*., 2010). The physical content revealed that parts of wheat plant like internodes (68.5%), leaf-sheath (20.3%), leaf-blade (5.5%), nodes and fines (4.2%) and grains and debris (1.5%) shows varied mass percentage of WS fractions (Mckean and Jacobs, 1997).

APPLICATIONS AND ROLE OF WHEAT STRAW

Fermentation industry: Synthetis and expensive substrates are being replaced by agro-industrial by-products for the production of a wide range of value added biotechnological products (Pandey, 1992; Raimbault, 1998; Mojsov, 2010). Filamentous fungi can efficiently use these by-products (Pandey *et al*., 1999; Singh *et al*., 2009; Mojsov, 2010). WS is an efficient substrate due to its better air circulation, loose study binding ability and efficient penetration by fungal mycelium. It is the cheaper substrate so it is a cost effective substrate in fermentation industry. Extracellular hydrolytic enzymes are being produced using WS under Sub-merged Fermentation (SF) as well as Solid-State Fermentation (SSF) systems. A large number of secondary metabolites can also be obtained by fermentation of WS (Yasin *et al*., 2010).

Study and pulp industry: Nonwood fibers containing cellulose and hemicellulose have a long history as a raw material in study and pulp industry (Singh *et al*., 2009). Straw and grasses are thus being utilized in larger amounts in this industry. Wheat straw can be easily pulped and bleached with about 40% yield and producing fine textured study (CWC and Domtar Inc., 1997). Cellulases and hemicelluloses' enzymes have central application for bio bleaching and production of dissolving pulp. The biosynthesis of these enzymes takes place using different cellulosic substrates including wheat bran, wheat straw etc., Gubitz *et al*. (1998), Bajpai (1999) and Singh *et al*. (2009).

Bioremediation: Bioremediation has the potential to restore contaminated environments at no expense. Treatment of wastewater through safer methods has always been the focus of environmentalists using various microbial and plant species (Javed *et al*., 2012). However, degradation of heavy metals has been a question mark for human being. Wheat straw, an abundantly available source is reported for sorption of heavy metals i.e., chromium. It is a very cheap and flexible substrate for metal ions. Functional groups like hydrolytic, carboxylic and phenolic groups in the lignin, cellulose and fatty acid units are ideal for ion fixation (Dupont *et al*., 2003).

Soil fertility and organic content: Crops grow by utilizing the minerals from soil. When crops are harvested the minreal contents of the soil are also lost and thus the supplementation of synthetic fertilizers is required. To provide a substitute for that organic wastes or agricultural wastes can be added to soil to fulfill the demand of crops. Wheat straw a major staple crop is harvested on a massive scale every year and the residues are helpful in maintaining the soil fertility if added as such or by mixing with the urea to balance the nitrogen content in the field (Murray and Bruehl, 1983).

Medicinal value: Wheat straw has been reported to relief from condition of biliousness (Drankham *et al*., 2003). It has been suggested that tooth disorders i.e., Pyorrhea can be prevented and cured using wheat straw. Chewing of wheat grass not only benefits by exercising of teeth and gums but also assists in digestion. It acts as brilliant mouth wash especially for sore throat and pyorrhea as well as it keeps tooth from decay and tooth aches. Moreover, it extracts out toxins from the gums and hence controls bacterial growth (Kumar *et al*., 2011). With dermatological context the ash of wheat straw has been reported to remove skin blemishes (Drankham *et al*., 2003).

Making biochar: Charcoal produced by pyrolysis of wood, straw, waste, etc. for capturing and storage of carbon is known as biochar. Growing concern about green house gas emissions make it crucial to find ways of finding carbon sinks along with the control over its discharge. Biochar is technically considered as most feasible way of creating carbon sink as well as for improving soil structure to enhance the productivity of soils about 2-3 times. The peculiar structure of biochar offers large surface area which is important in improving the soil texture, arability, retention of nutrients and provides surface for growth of beneficial microorganisms. Moreover the water holding capacity of soils is also increased by adding biochar to them, thus helps prevent leaching of valuable nutrients into streams and rivers (Goodall, 2010).

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