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Review

Utilisation of common grain crops in Zimbabwe

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Grain production in Zimbabwe is very important to food security of the country and therefore should be promoted. Potentially, knowledge on utilisation and value addition of grain crops can be viewed as strong strategies in promoting its production. Value addition results in various products from each grain crop and this may increase utilisation and profitability. In this review paper, an attempt is made to describe the utilisation and value addition of common grain crops to Zimbabwe which include maize, soybeans, wheat, sorghum, groundnuts, pearl millets, bambara nuts and cowpea.

Key words: Zimbabwe, grain crops, value addition, utilization.

INTRODUCTION

Grain crops like maize, soybeans, wheat, sorghum, and many others contribute immensely to food security of Zimbabwe. For example, the country needs about 1.8 million tons of maize annually while approximately 500,000 tons of wheat is required annually (Gono, 2008). Most of these grain crops have high content of carbohydrates, for example maize, sorghum and wheat, while other grain crops have high levels of protein and fats like soybeans, dry beans and ground nuts (Šramková et al., 2009). Carbohydrates and proteins are essential to human diet for energy and growth, respectively. However, despite the importance of grain crops, their production is facing a decline in Zimbabwe. The decline may be attributed to a number of factors that may include pests and diseases, poor management, climatic variability and poor pricing among others. In the short and long term, poor pricing of grain crops is significantly affecting choice of crop to grow by most farmers (Jayne, 1994). Since the sole buyer of most grain crops in Zimbabwe is Grain Marketing Board (GMB), the price that it offers to farmers is far below the cost of production. In addition, securing local market for most grain crops is a constraint in many developing countries including Zimbabwe. This discrepancy has led many farmers to shift from growing grain crops to cash crops like tobacco, cotton and others. The shift from grain production to cash crop production undermines food security and perpetuates poverty in developing countries. The gap between production and consumption levels is normally bridged by importation of grain by governments of developing countries especially maize and wheat. Importation of grain result in loss of much needed foreign currency that may be used in other critical sectors like health.

An alternative to stimulate an increase in production of grain crops and profitability among farmers is to promote value addition (Ja'afar-Furo et al., 2011). Value addition is simply defined as a process of increasing value and consumer appeal. According to Coltrain et al. (2000), value addition means improving the product economically by altering its current place, time and form characteristics. Value addition is divided into three ways; primary, secondary and high end processing. Primary processing involves proper cleaning, grading and packaging. While secondary processing encompasses basic processing, packaging and branding. Basic processing is normally carried after cleaning and grading, it involves grinding of grain into meal or other products. Packaging and branding gives the product uniqueness which is important in marketing. The final way of value addition is high end processing and this involves modern processing technology,

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which may be complex although it is high rewarding. A good example of high end processing can be drawn from extraction of ethanol from maize grain which may be used in production of bio – fuels. Value addition is much dependent on the grain crop since they differ in their chemical constituents.

The following section will look at value addition of grain crops that are commonly grown in Zimbabwe which include maize, soybeans, wheat, sorghum, groundnuts, pearl millets, bambara nuts and cowpea.

Maize

The first step in increasing value of maize grain is centred on proper drying of the crop to safe moisture levels (13 to 15% moisture content). This will reduce the spoilage due to insects and pathogens, thereby increasing shelf life of maize grain (Wilcke and Morey, 2009). The next step of adding value of grain involves cleaning, grading and packaging the product. Cleaning removes all extraneous material like weed seeds and soil thereby improving appearance and this may attract higher price. Grading of maize grain may be done according to size using sieves and this increases quality of the product. Processing should be done aiming for specific and unique product for purposes of branding. For example, maize can be grounded to produce livestock feeds, samp, roller and refined meal. Packaging of maize grain and its products is also significant in value addition. Research for different needs in packaging for the market is very important in value addition. There are various ways dry maize can be utilized. The grain may be popped in a hot plate and eaten as hot popped maize. Alternatively, the grain may be boiled and consumed as whole grain or the grain is partially grounded to produce mealie rice, sometimes called samp. The whole grain may be milled to produce mealie meal or flour which is used for various purposes. The meal is usually used to make cooked paste while the flour is used to prepare unleavened or leavened bread, biscuits and corn bread. The mealie meal can also be used to make traditional non-alcoholic and alcoholic beverages. Maize grain can be processed to produce livestock and poultry feeds. Similarly, maize plants especially after flowering stage can be used as fodder to dairy and draft cattle.

In the commercial industry, maize grain is used in the wet or dry milling to produce secondary and derived products from maize that include tortillas, maize flours, chips, snacks, breakfast cereal, maize oil, soft drinks, starch, ethanol for biofuels and wine like whisky (Mejia, 2003; John and Babynath, 2011).

Soybeans

Soybeans have various products that can be derived from its grain. When the grain is harvested in its fresh state, it can be used to produce soy foods like miso, tofu, tempeh, soy sauce traditional to countries like Taiwan, Japan, China, Indonesia, India, Thailand, Uganda and Nigeria (Thoenes, 2007). Fresh whole grain of soybeans can be processed to produce diary products substitutes that include soy milk, cheese, margarine, soy ice cream and soy cream cheese (Jaiswal, 2009). When the grain is dried, it can be primarily processed into soy flour, textured vegetable protein, soybean oil and soy meal. Soy flour is used to make soy bread and soy pasta. Textured vegetable protein is made up of different vegetable products and can be a substitute of meat (Jaiswal, 2009). Oil extracted from soybeans can be used for edible purposes and in industry as a source of key fat ingredient (Thoenes, 2007). When oil is extracted from soybeans, the by-product that is produced is soy meal which can be fed to livestock. However, this meal is believed to have anti-nutritional substances like trypsin inhibitors, saponins, phytoestrogens, glucinins, goitrogens, lectins, urease and other substances (CRC, 1983; Liener, 1994). The anti-nutritional factors can cause infertility to livestock like cattle and sheep (Adams, 1995). The anti-nutritional factors in soybeans can be reduced by roasting or heating the grain.

Wheat

Wheat is mainly added value in milling and bakery industries. Flour milling takes the major share of wheat processing and the main product is wheat flour. Most of wheat flour is sold to grain based food manufacturers including bakery industry. Some of the wheat flour can be begged and sold to ingredient distributors. Apart from milling wheat into flour, the crop product can be used to produce livestock feed, starch and ethanol (FAO, 2009). In the bakery industry, several products can be made depending on type of wheat flour (and wheat type). Although, blending of different types of wheat flour can be employed in milling industry to produce bakery products like pastries, sweet goods and cakes. The bakery products include bread (white, brown, whole wheat and other variety breads), rolls (hamburger, hotdog, muffins and bread type rolls), sweet yeast goods (doughnuts), soft cakes, pies, pizza crust, cookies and crackers (Lou and Wilson, 1998). In the flour milling industry, bran is an important by product with several uses (Hemery et al., 2007; Javed et al., 2012). Wheat bran can be used as an alternative to synthetic medium in fermentation processes (Pandey, 1992). Apart from that, wheat bran can be used as a supplement of nitrogen in medium for the production of enzymes like protease, amylase and glucoamylase (Vishwanatha et al., 2009). In addition, the compounds from wheat bran like lingocellulosic can be used to remove heavy metals like Cu II, Pb II and Cd II from industrial waste waters since the latter pose a health risk.

Another potential use of wheat bran is in bio ethanol production as an alternative to fossil fuel which is facing depletion (Shafiee and Topal, 2009; Manikandan and Viruthagiri, 2009). According to Gomez et al. (2003) bran

of wheat can be used to supplement wheat flour and baked products with cheap vitamin and other nutrients. Apart from that, wheat bran can be used to make livestock feed formulations and its presence has been found to improve daily milk yields (Tahir et al., 2002).

Sorghum

Depending on sorghum variety, there are multiple functions the crop can be used for. Sorghum can be used as forage or silage crop to feed livestock and as a grain crop (Rao et al., 2010). In Zimbabwe, the main sorghum variety grown is Kafir (*Sorghum bicolor* Kaffrorum) and is mainly used as a grain crop. Sorghum grain can be used as a substitute to maize and wheat meals although it can also be used to supplement feed for poultry, horses and swine. However, sorghum with low tannin should be used to make livestock feed as their presence decrease feed efficiency by 5 to 30% (Rooney, undated). Sorghum grain can be added value by processing it into opaque beer and this is common in Zimbabwe and South Africa. Similar to other grain crops, sweet stalked and high energy sorghum can potentially be used in ethanol production and electricity (Celada, 2008). Sorghum can be processed into flour and may substitute wheat. The flour is used in the bakery industry to produce different products that include cakes, bread, biscuits flakes and other products. Value addition of sorghum also involves popping by exposing the grains to high temperature for a short time. Different methods of popping have been used and include hot air popping, gun puffing, popping in hot oil and microwave popping. Furthermore, popping sorghum is known to improve shelf life and nutritional quality of the grain.

Popped sorghum can further be used to make snack foods (Gundboudi, 2006). Sorghum has also been reported in starch production suitable for diabetic and obese people (Dicko et al., 2006). Sweet sorghum can also be used to make syrup (Mazumdar et al., 2012).

Groundnuts

Groundnuts can be used as freshly harvested seeds or dry kernels. Fresh harvested pods may be boiled or roasted with or without salt and served as a snack. Post-harvest technologies in dry groundnut are very fundamental to value addition of the crop. These technologies include adequate drying, cleaning, de-stoning and grading of ground nuts. The processing of dry groundnuts begins with shelling and can be done by hand or machinery; it also adds value to the crop. Nutritive groundnut haulm from shelling can be used to feed livestock while the hulls can be used to make compost manure. Shelled groundnuts can also be boiled or roasted with or without salt and served as a snack (Singh and Diwakar, 1993). The most popular value added product from groundnuts is peanut butter especially in Western countries. The production of peanut butter involves pre-cleaning, shelling, grading, roasting, blanching, grinding, cooling and packing. The butter is used as spread on bread and is used in the food industry to make candy, cookies and sandwiches (Kadam and Chavan, 1991). Another important valued added product of groundnuts is oil which is used in cooking or can be processed in margarine and soap making. The groundnut oil is also used in production of candles, cosmetics, suckericide, leather dressing, furniture and creams; although on a low scale.

Oil extraction results in a by-product called groundnut cake. Groundnut cake can be used in bakery industry to make biscuits, breads and cookies. The cake can be fermented to make the products easily digestible, tasty and nutritious. In addition, groundnuts can be processed into milk by soaking them in 1% sodium bicarbonate for 16 to 18 h. Groundnut milk when fermented can be used to make yoghurt, substitute up to 20% whole milk in ice cream production (Singh and Diwakar, 1993).

Pearl millet

Pearl millet tolerate stresses like drought, low fertility and high temperatures and is grown in areas where other cereal crops like maize cannot survive (Hanna and Cardona, 2001; Basavaraj et al., 2010). Therefore, value addition of pearl millet is very important to increase its production and utilisation. Similar to sorghum, pearl millet is grown for fodder or grain purposes. However, in world's poorest countries, pearl millet is mainly grown as a grain crop. The utilisation of pearl millet has remained very low possibly due to a number of anti- nutritional factors the grain crop has, for example, phytate and poly phenols that are found in the grain. Therefore, processing of pearl millet can add value and increase its utilisation. The first process is dehulling or decortication by removing outer layers of grain reduces fibre, ash and fat, increasing nutritional quality. Milling is the second process and it produces flour which can be used to make porridge. However, the shelf life of that flour is very short due to the presence of high fat content. This limitation can be reduced by moist heating and drying the grains followed by decortication. Blanching has also been reported to increase shelf of the flour without changing nutrient content of the flour (Chavan and Kachare, 1994). The process is achieved by submerging grain for shorter period and then drying. The flour from milling pearl millet is used to make bakery products like bread, biscuits and cakes. However, flour of pearl millet is not good for bakery due to absence of gluten and it makes dough of poor consistency (Badi et al., 1976).

Grain processing that involves dehulling and milling results in a by-product called bran that can be used to make edible oil and deoiled bran can be a source of dietary fibre. Dietary fibre can be used to make flakes for obese people. The third process of pearl millet is malting

and is done by allowing limited germination of the grain under moist controlled environments. Malted pearl millet is normally used in the brewery industry to make beer. Other processes that reduces the anti-nutritional factors and increase shelf life include acid treatment (Hadimani and Malleshi, 1993) and dry heat treatment (Poonam, 2002). Another process of pearl millet that can improve digestibility and shelf life is parboiling. Parboiled grains can be cooked to produce rice like products. Other value added products of pearl millet are non-alcoholic beverages (mahewu), flakes, drinks and pops. Pearl millet grains can also be processed into livestock feeds while its stalks are used to roof traditional houses (NRAA, 2012).

Bambara nut

According to Hillocks et al. (2012), bambara nuts can be eaten while it is fresh by boiling the seeds. Dried seeds can be milled into flour which is used to make flat cakes, biscuits and porridge when mixed with other cereals. In Zimbabwe, the nuts are pounded and mixed with onions, tomatoes and oil to make a relish. In order to improve protein content of traditional weaning foods, the legume grain can be used to make bambara- fortified high protein fermented maize dough (Mbata et al., 2009). Wheat flour that is used in biscuit, bread and cake production lacks certain essential amino acids like lysine, tryptophan and threonine (Kent, 1975). Grain legumes that include bambara nuts can be used to make fortified wheat flours that are nutritive (Abu-salem and Abou-Arab, 2011). Similar to soybeans, bambara nuts can be used to produce milk by soaking overnight, dry frying the seeds, homogenising and removal of insoluble material (Brough et al., 2003). In order to increase value of the nuts, canning has been reported in Ghana and Nigeria (Hillocks et al., 2012).

Despite the high nutritional value of bambara nuts, anti-nutritional factors have been reported that include tannins, trypsin inhibitors and also poor dehulling properties. Fermentation reduced anti-nutritional factors while hot soaking improved dehulling properties (Barimalaa and Anoghalu, 1997).

Cowpea

Cowpea is predominantly grown in Africa as the crop can tolerate dry environments than other legumes like soybeans. Therefore, its utilization and value addition is important in Africa. This legume crop can be grown for fodder or grain purposes. When the crop is grown under stressful conditions, the foliage may be used to feed livestock as few pods will be produced. Fresh green cowpea pods can be used in the same way as snap beans while tender cowpea leaves can be served as a vegetable. Dry mature seeds can be boiled and served or canned or frozen to preserve. Dried cowpea grain can be milled into flour or meal which can be packaged in unbranded or branded packets (Gomez, 2004). The difference between flour and meal is that flour is more finely milled than meal. Cowpea meal can be used to produce ready to use cowpea dry meal, fritters which is used as a snack or breakfast (Nagai, 2008). A number of products can be made from cowpea flour that includes cakes, dumplings, rock buns, doughnuts, biscuits, pie, fritter, fried cowpea paste, thick cowpea porridge and many others (Randolph et al., 1981). Besides milling cowpea, innovative technologies like decortication, fermentation and extrusion has been incorporated in the past to produce weaning mixes and blending, new formulation and fortification (Nyankori, 2002), for example weanmix introduced in Ghana in 1987 (Nagai, 2008).

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