EMMER WHEAT - AN ETHIOPIAN PROSPECTIVE: A SHORT REVIEW

Melese, Bethlehem[1], **Satheesh,** Neela[1] and **WorknehFanta,** Solomon[1]

[1]Department Postharvest Technology, Faculty of Chemical and Food Engineering,
Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia
*Corresponding author: solworkneh@gmail.com

Abstract:
Cereals are producing in a large volume as compare with other crops in Ethiopia because they are the principal staple crops. Small amounts of ancient wheat species may still be grown in some countries for traditional foods, but there has been renewed interest in them in recent years as they have been proposed to be rich sources of bioactive components and hence suitable for producing high value food products with enhanced health benefits. Emmer wheat is considered as one of the underutilized cereal crop and mostly produced in the highlands of the country. Very few selective countries are still producing and consuming the Emmer wheat. In Bale zone south eastern Ethiopia a significant amount of emmer wheat is producing and this area is considered as one of the major crop in this region. Emmer wheat is commonly used for the preparation of different foods which are traditionally recommended for mothers as a special diet after child birth and used for healing of broken bones faster in Ethiopia. In Bale zone of Ethiopia four varieties of emmer namely Haydaroo, Sinana 01, Lameso and Local are cultivated in both 'meher' and 'belg' cropping seasons. In this review we are presenting the evaluation of the emmer wheat and their nutritional quality.

Key words: Emmer wheat, Ethiopian Oats, Nutritional quality, Traditional usage

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1. INTRODUCTION

Ethiopia is growing wide variety of tropical and temperate agricultural crops due to large variation in altitude. Cereals are considered as the most important and 90% of the national agricultural production is covered by cereals. The major cereals producing in Ethiopia are teff, barley, wheat, emmer wheat, maize, sorghum, millet and rice (CSA, 2017).

Emmer wheat (*Triticum dicoccum*) is tetraploid wheat derived from the intersections of the wild species of *Triticumdicoccoides* and *Triticum durum* (Pagnotta et al., 2005). In Africa it was first cultivated in North Africa particularly in Morocco and gradually reached to Egypt during the 5th century BC (Nesbitt and Samuel, 1996) then it was introduced to Ethiopia highlands before 5,000 years ago (Helbaeck, 1970; Feldman, 1979). Based on their evolution of diverse characteristics and numerous intermediate forms, emmer wheat is believed to have a long history in Ethiopia (Tesfaye et al., 1991).

Emmer is still cultivating in Ethiopia (Beteselassie et al., 2007), CSA (2016) reported that it covered about 24 thousand hectares and produced 492 thousand quintals in year 2016 (Table 1). Emmer wheat represents about 7% of the country's wheat production and primarily it was produced for house hold consumption and occasionally for regional market (Andrea and Haile, 2002). Emmer wheat is cultivated in marginal land in almost all regions of country including Bale, Arsi, Shewa, Harerge, Wollo, Gojam, Gondar and Tigray. The cultivation reported in 1,800-3,000m altitude (Wubishet and Tilahun, 2016).

Bale zone of the southeastern Ethiopia is a potential area for production of emmer wheat in both 'meher' (June to September) and 'belg' (March to May) seasons. It is one of the major crops in the region and contributes more than *Triticum durum* (Demissie and Hailegiorgis, 1985). In Ethiopia emmer wheat is known in different local names as '*Aja*' in Amharic, '*Hyassa* or *Matajebo*' in Oromo language and '*Arras*' in Tigrigna. Locally this crop is used in various ways as food in the farming community. Emmer wheat usually de-husked by traditional methods and ground into flour, this flour is further baked into non-fermented bread known as 'kita'(leavened bread).

Moreover, in some communities it is a common practice to cook the flour with milk or water to make soft porridge. Especially, in Bale highlands emmer is used to prepare '*cankita*' (local spaghetti) (Tesfaye, 2000). The farmers and consumers of emmer wheat strongly believe that it has some medicinal values, especially, they believe that broken bones heals faster when emmer is consumed in the form of porridge. It is also traditionally recommended for mothers as a special diet in maintaining their health and strength after childbirth (Tesfaye, 2000). Additionally, Ethiopian farmers appreciate emmer wheat as compared to other wheat in that emmer doesn't cause any digestion disorders when consumed in any form and considered as a healthy food.

Post harvesting operations of crops in Ethiopia are still traditional, which has direct impacts on food security of the country (Negassa et al., 2012). Increasing yield is commonly mentioned as an important issue for increasing food security (Bekele et al., 2009). The potential of increasing production and productivity is high through possibilities of both horizontal and vertical expansion. Other interventions of increasing food security includes: expanding production, developing varieties for different agro-ecosystems and improvement of post-harvest practices (Shimelis, 2000).

Improvement in post-harvest management practices will help to maintain the quality of the grain for end- uses and avoid quantity losses. Hence it is necessary to develop effective strategies for post-harvest chain functioning which avoid deterioration of grain in quality and quantity (Tadesse et al., 2017).

2. TYPES OF WHEAT AND THEIR CULTIVATION

Wheat is one of the cereals used extensively in many parts of the world for the preparation of bread and many bakery products (Fincher and Stone, 1986). In its various food forms, wheat provides a large proportion of the world's nutrition. It is the most important cereal crop in the world (Pena et al., 2006) which is the principal source of energy, protein and dietary fiber for a major portion of the world's population. Wheat is cultivated in about 120 countries of the world. The major wheat producing countries are China, USA, India, Canada, Australia etc. (FAO, 2000). Historically wheat (*Triticum spp.*) has played an important role in human nutrition as a dietary staple (Liangli Yu and Rong T. F. S, 2012)

Wheat is the most important in food and economical cereal crop around the world (David Pimentel 2009), it is a principal source of energy, protein, and dietary fiber for a major portion of the world's population (Abdel-Aal and Huclw 2002). *Triticum aestivum* is the major wheat species grown throughout the world, which accounting for about 95% of the wheat which are grown annually. *Triticum aestivum* is a hexaploid species which is usually called "common" or "bread" wheat.

Bread wheat is a youngest species, arisen in cultivation about 10,000 years ago, it was relieved to that spontaneous hybridization of cultivated tetraploid wheat with the wild grass *Triticum tauschii* (Dubcovsky and Dvorak, 2007) was the evolutionary reason. Bread wheat has been transported to all continents exception of Antarctica. It has become the major staple crop in temperate zones. This migration has been facilitated by the development of immense genetic diversity, allowing the selection of forms adapted to a wide range of local environments. The development of such diversity results from high genome plasticity (Dubcovsky and Dvorak, 2007) and there is no reason to doubt that further diversity will continue to accumulate at a similar rate in the future.

In addition *Triticum turgidum* var. *durum*, a tetraploid species grown each year in hot dry conditions located surroundings of the Mediterranean Sea and similar climates in other regions and known as "durum wheat". Pasta is the product which is producing from the durum wheat. Other more "ancient" wheat species were cultivated historically but are today only grown on small areas.

Cultivated einkorn descended from a wild subspecies through mutation, still forms a

component of the Zanduri wheat population found in Georgia and is a useful source of disease resistance (Zeven and Wet, 1982).
The most well-known and widely studied of these are the diploid wheat einkorn (*Triticum monococcum var. monococcum*), tetraploid emmer (*T. turgidum var. dicoccum)* and hexaploid spelt (*T. aestivum var. spelta genomes*) which are now considered to belong to the same species as bread wheat. Spelt, emmer, and most forms of einkorn differ from bread and durum wheat's in being hulled (i.e. the glumes remain tightly closed over the grain and are not removed by threshing).
The wild and cultivated emmer wheat can be found in southern Turkey, Iran, Israel, southern Syria, and Jordan, as well as in Ethiopia, India, and the Mediterranean countries. Emmer may have been domesticated earlier than einkorn and was the predominant type of wheat cultivated throughout Europe and the Mediterranean for thousands of years before durum wheat appeared. Durum wheat is still grown widely in Italy, Spain, North Africa, West Asia, and Ethiopia(Melinda et al., 1996).

3. USES OF EMMER WHEAT

Currently emmer wheat is mainly used as human food, although it is used for animal feed (Zhukovsky, 1964).
In ancient time emmer was used to feed chickens and as a fodder for horses (Gadea, 1954). For human consumption in Egypt and Italy emmer was used for making breads (Samuel, 1994) and beer. Besides to this ancient Egyptians uses emmer wheat with salt as a medicine. Additionally in Italy emmer is traditionally consumed as whole or crushed grains in soup, and it is used to make *puls* (porridge) and *alica* (groats) (Braun, 1995). Nowadays, emmer wheat is commonly cultivated by organic farmers and in marginal environments like in Turkey, where it is mainly used for animal feed and rarely to make bread for those who don't have access to modern wheat (Alessandra et al., 2009).
In Ethiopia emmer wheat grains passes through various steps for traditional food preparation. De-hulling is a common practice applied for Ethiopian emmer based foods, which is performed by pounding the grain with a traditional wooden mortar and pestle to separate bran from the grain. Then the de-hulled grain is sun dried for few days, which split to become cracked grain (fig 1 A). This cracking process is commonly made by using traditional stone grinder. Then the cracked grain is used for preparation of '*Kinche*' (fig 1 B). For the preparation of '*Kinche*' the grain is de-hulled, roasted lightly, cracked and cooked in boiled water and after adding salt and butter it is used. It is prepared occasionally as alternative dish when others are not readily available. The de-hulled grain is further sun dried and milled then the flour is used for the preparation of leavened and unleavened staple bread and porridge (Andrea and Mitiku, 2002).
Emmer based foods are prepared as main, and side dishes which are prepared in different traditional methods and used for separate reasons. Emmer is used to make traditional foods like *kita* or *ambasha* (flat steamed bread), *kinche* (boiled coarse grain), *Genfo* (porridge), *kolo* and '*cankita*' (local spaghetti) (Geleta et al., 2009). Some of the food like '*Genfo*' (fig 1 C) and 'Atmit'(fig 1 D) are prepared from the flour of emmer wheat, which are used for breast feeding mothers with the belief that they enhance breast milk production and also used to be a good source to heal broken bones.
In Ethiopia,*" Genfo"* (fig 1C) is one of the most widely consumed food commonly for expectant mothers. 'Genfo' is prepared from the flour of the roasted emmer wheat. During the preparation the grain is milled and then the flour is added with some salt in boiled water and cooked with frequent stirring. It is usually prepared with ingredients like butter with 'berbere'. A hole is made in the middle of the porridge, which is commonly used to put the ingredients.
Similar to genfo, 'Atmit' (fig 1 D) is prepared from flour of emmer but for 'atmit' more water is added. Thus, it is a drink served hot in a cup. It is a very important dish during childbirth.
In south central Tigrai Ethiopia, emmer is commonly used to make a side dish '*kolo*',

which is agreed by farmers that of all available cereals emmer makes the best quality '*kolo*' because the grains are very tender and have a sweeter test (Andrea and Mitiku, 2002). Similarly, in South India, emmer is used to prepare traditional foods like '*godihuggi*' (polished grains cooked, mashed and heat over a low fire), '*sajjan*' (roasted coarse semolina) and 'holige' (dough mixed with cooked and ground chickpea) (Patil et al., 2003 and Hanchinal et al., 2005). Emmer products are also becoming popular in USA & Canada, particularly, for specialty bread making (Singh, 2006). In addition to its food products emmer wheat grains was also used for making beer. Generally, depending on their cultures and traditional perspectives different countries uses emmer wheat for making their traditional foods.

Considering the fact that consumers are more interested in functional foods, the industrial possibilities of using emmer for food products is promising. Maria Z. et al (2010) confirmed the suitability of emmer flour for bread, biscuits, cake and pasta formulation. Similarly studies evaluating the possibilities of emmer in beer making (Bendettie et al 2016) have shown promising results. However, much work is needed to evaluate the nutritional and functional properties of Ethiopian emmer wheat.

4. NUTRITIONAL QUALITY OF EMMER WHEAT

The increasing attention to sustainable agriculture and the demand for organic foods have raised the interest in emmer wheat (Galterio et al., 2003). Small amounts of ancient wheat species may still grow in some countries for traditional foods. There has been renewed interest in them in recent years as they have been proposed to be reach sources of bioactive components and hence suitable for producing high value food products with enhanced health benefits (Lachman et al., 2013).

Like other ancient wheat emmer has a unique composition such as starch, which may play a role as functional food ingredients because it is rich in fiber, proteins, minerals, carotenoids, antioxidant compounds and vitamins (Magdalena et al., 2016). Emmer wheat is a minor cereal today, should know new development due to the nutritional value of its grain, the special taste of its products and its characteristic of resistance to pests and diseases. It is particularly appreciated for its content of resistant starch, fiber, carotenoids and antioxidant compounds (Serpent et al., 2008), while compared with other ancient wheat.

The nutritional value of emmer wheat is confirmed by medical data (Strehlow et al., 1994; Italiano and De pasquale, 1994), mainly due to its high fiber and antioxidant compound concentrations, high protein digestibility (Hanchinal et al., 2005) and high resistant starch contents and lower carbohydrates (Mohammad K et al., 2006). The low glycaemic index value of emmer wheat makes it particularly suitable for diabetes (Buvaneshwari et al., 2003) and because of its richness in minerals, fiber and poor in fats it is recommended in the diet of people suffering from allergies and high blood cholesterol (Barcaccia et al, 2002).

Limited data are available on the contents and composition of nutritional value of emmer wheat. Nevertheless, the data that are available shows that emmer wheat differs from modern wheat and oats in some components (Table 2). As ancient wheat emmer wheat has a unique composition because it is rich in protein, minerals carotenoids, antioxidant compounds and vitamins which make it nutritionally superior cereal sources (Lachman, 2013).

Emmer wheat is reported to have higher protein content 18g (Table 2) than wheat and oat. This means it provides an adequate amount of essential amino acids important for human health. Another key advantage of emmer is a very nutritious crop loaded with essential minerals such as magnesium and zinc. It has high content of magnesium (1090 mg) and zinc (22.8 mg) than wheat and oat (Table 2), which has the ability to boost immune system and build bones. Also emmer is appreciated particularly for its content of antioxidant

(Serpen et al., 2008). It has significantly higher amount of total antioxidant (257.6mg) as compared with oats and wheat (Table 2), which plays a role in protecting against heart diseases, diabetes stroke and some cancers (Serpen et al., 2008). According to the value mentioned on Table 2, emmer wheat contains the same amino acids as modern wheat. However, it is characterized by higher protein content in grains and higher content of amino acid. Therefore, the grains of emmer wheat can be used for the production of nutritional value diet.

5. CONCLUSIONS

There are many types of the modern and ancient wheat varieties are available in the world. Some of the ancient wheat varieties are replacing by the modern wheat, but, they are having clear share in dietary pattern of the some communities and those communities strongly believe about their properties like Ethiopians. Emmer wheat is ancient wheat still cultivating and using in Ethiopia. Moreover, Ethiopians consider Emmer wheat as the Ethiopia Oats, so there is a lot to do research related to this issue. Scientific development is limited at the stage of the varietal development. In the rest of the countries which are growing the emmer wheat there is no full profile of their nutritional properties. Even though people believe about the nutritional properties but, there is no clear evidence, so, it is a best topic for further research on nutritional evolution and value addition of the crop.

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Table 1. Emmer and bread wheat area coverage and production statistics in Ethiopia from 2012-2016

S. No.	Year	Crop	Area coverage (ha)	Yield (qt)
1	2012	wheat	1,627,647	39,251,741
		Emmer wheat	26,514	436,338
2	2013	wheat	1,605,654	39,251,741
		Emmer wheat	35,617	616,502
3	2014	wheat	1,663,837	42,315,887
		Emmer wheat	27,889	508,059
4	2015	wheat	1,664,564	42,192,572
		Emmer wheat	22,105.72	402,689
5	2016	Wheat	1,696,083	45,378,523
		Emmer wheat	24,041	491,796

Source (CSA 2017)

Table 2. Average Nutritional value of emmer wheat, oats and wheat in 100 g

S. No	Nutritional composition	Emmer wheat	Oats	Wheat
1	Protein	18g{2}	16.89 g{1}	9.6g{1}
2	Starch	47.7g{3}	66.27g{1}	74.48g{1}
3	Total dietary fiber	9.2g{4}	10.6g{1}	13.1{1}
4	Lipid	1.02g{5}	6.9g{1}	1.95g{1}
5	Vitamins			
	Thiamin	NA	0.763mg{1}	0.297mg{1}
	Riboflavin	NA	0.139 mg{1}	0.188mg{1}
	Niacin	NA	0.961mg{1}	5.347mg{1}

6	Minerals			
	Calcium	NA	54m[1]	33mg[1]
	Iron	34.1mg[6]	4.72mg[1]	3.71mg[1]
	Magnesium	1090mg[6]	177mg[1]	117mg[1]
	Zinc	22.8mg[6]	3.97mg[1]	2.96mg[1]
	Potassium	NA	429mg[1]	394mg[1]
7	Antioxidant	257.6mg (Rudico variety) [7]	4.61mg[8]	144.8mg (Granny Variety) [7]
8	Amino Acids		Coker 227variety	
	Lysine	2.67g[2]	4g[8]	2.64[2]
	Threonine	2.74g[2]	3.5g[8]	2.78g[2]
	Isoleucine	3.2g[2]	4.01g[8]	3.11g[2]
	Valine	3.42g[2]	5.28g[8]	3.43g[2]
	Phenylalanine	4.03g[2]	5.48g[8]	4.02g[2]
	Methionine	0.9g[2]	1.82g[8]	1.15g[2]
	Leucin	5.64g[2]	7.5g[8]	6.12g[2]

Note: NA= data not available, most of the data are not variety based. **Reference**: USDA 2016[1], Jiang et al., 2008[2], Konvalina et al.,2008[3], Peter et al., 2015[4], Hanchinal et al., 2005[5], Zhao et al., 2009[6], Lachman et al 2012[7], Morey et al., 1983[8]&Magdaléna L B and Veronika Č, 2015[8].

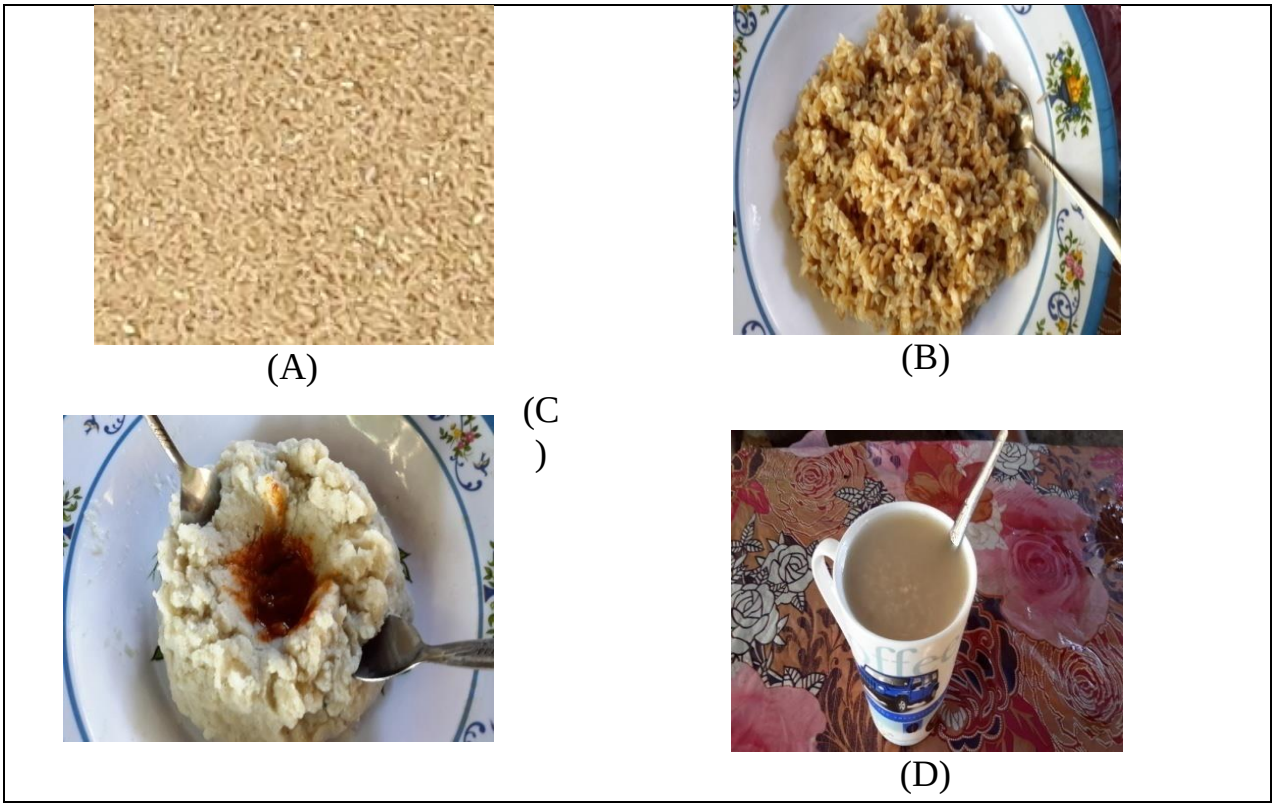

Figure 1. Some of the traditional foods made from emmer wheat in Ethiopia, A.de-hulled cracked grain of emmer for ready to usage; B. *Kinche*; C. *Genfo*; D. *Atmit*)

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