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REVIEW

Flat bread: ingredients and fortification

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Abstract

Flat bread is simple bread made from flattened dough of flour, water, salt, yeast and other optional ingredients. The manufacture of flat bread necessitates special characteristics in flour and dough. Additional (optional) ingredients may be used for processing aids which are essential in particular in the bread-making process, in improving the quality and for fortification of bread to have more nutritive value. Milk, eggs, other cereals, legumes, dates or date syrup, dried fruits, leafy vegetables, cassava, green banana, flaxseed flour, sesame, black seeds, species, meat, and dried or fresh herbs might be added to the formula of the bread. In addition to protein, vitamins and minerals, fibres are the most commonly used nutrients for fortifying flat breads. More development of flat bread products is essential.

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Introduction

Flat bread is as old as civilization. It is eaten with almost every meal in the Middle East, North Africa and Central Asia. Flat breads are often served freshly baked and produced in both the home and bakeries. The consumption of flat bread is increasing throughout the world; both from traditional production and commercial mechanical bread production of Middle East breads. At the home level, dough is mixed, allowed to undergo bulk fermentation, divided and rounded by hand, and rested on a flat surface, then shaped using hand and fingers. The flattened dough pieces are then placed on wooden boards for the final proofing stage. The dough is then placed in the oven for baking until it develops the appropriate crust colour to be removed with a peel. Semi-automated and fully automatic production systems are applicable to producing flat bread.

Production of Middle East flat bread requires the selection on many criteria in the flour which affect both quality and shelf life; these include water absorption, protein or gluten quality, baking conditions, gelatinization of starch, and moisture content. A correct balance of visco-elastic properties is important during the sheeting and moulding steps of flat bread. The production steps include the mixing of flour, yeast and salt with water to get the optimum development of the dough which can be recognized when the dough appearance changes from being dull and rough to smooth and silky. The dough matures, and the gluten is developed by the biological action of the fermentation through gas production which helps the condition of the dough and brings about its mellowing. The dough is turned and punched a number of times during this step in order to expose the yeast to new food sources. The dough mass is divided into pieces of desired weight. The dough pieces are shaped in rounded pieces, rested after the mechanical stress, and sheeted to desired shape and thickness. The sheets are rested at room temperature on wooden boards or on the conveyer belts. The baking of flat bread is carried out at high-temperature ovens and for a short time. The baking time and temperature vary according to the thickness of the sheeted dough. Mechanical ovens are getting more and more popular; they operate at 350–500 °C for 20–45 s then the flat bread is cooled and packaged.

Middle East flat breads are typically round in shape; bread diameters range from 120 mm to 650 mm (5–25 in), while

Figure 1 Al-Mashrouh flat bread.

Figure 2 Thin kmaj flat bread.

their thickness ranges from thin to thick (30 mm, 1 in); the crust is very thin and light with brown or dark spots. The proportion of crumb is small with a coarse structure and intense with a low specific volume. Flat breads have higher crust to crumb ratio than pan breads. In addition to the previously described quality factors, there are other factors such as proper pocket formation, easy separation of top and bottom layers, white creamy colour of bread crumb (unless baking wholemeal), fine uniform cell structure, and easy tearing; this evaluation should be related to the 'mouth feel' of the bread which should be chewy without being tough.

Middle East flat bread also divides into leavened and unleavened bread. Leavened products include pita or Middle East bread, kmaj, tannouri, barbari, mashrouh as in (Figure 1) and lavash. Unleavened products include traditional tortillas, chapatti, paratha, shrak and lizzagi. Flat breads may be classified into two major groups: single layered flat bread and double layered flat bread. The most important processing difference between the two types of flat bread is the proofing stage is very short, that is, less than 2 min for single layered flat bread; and pocket formation is prevented by either a long baking time at lower temperature and by punching the sheeted dough before baking. In the twice layered flat bread, the final proofing period might exceed 20 min, during this time the sheeted dough is aerated and its surface is dried out which results in skin formation and the subsequent puffing and formation of a double layered product (Amr, 1988; Qarooni *et al.*, 1989, 1992).

Pocket formation is important for quality evaluation of twice layer bread, for example, kmaj bread as in (Figure 2) (Amr, 1988). The most names of flat bread consumed in Arab and Middle Eastern countries are shown in (Table 1).

Table 1 Some of Middle East's flat bread names

Country	Name of bread
Jordan	mashrouh, tannouri, taboun, thick kmaj,thin kmaj, baladi, markook, armani, lizzagi or saaj, shrak
Egypt	shamy, baladi, eish baladi, bakoom, battawi (mashtouh), shamsey, feno
Lebanon	khubz, middle east, baladi, markouk, tannour, armani,
Syria	muraqqad, kubz or kmaj, tannouri, taboun, armani, mashrouh,
Gulf countries	tannouri, middle east, rogag (saaj), mafrood (middle east), burr, tannouri, tammees, korsan.
Iraq	lebanese, kubbz (tannouri), khubz, saaj, sammoun
Iran	naan-e sangak, naan-e barbari, taftoon, lavash,
Turkey	pide, borek, tannouri
African countries	chapati, injera, shamsi, kisra
Asian countries	chapati, roti, naan

Ingredients of flat bread

The four basic ingredients of flat bread are flour, water, salt and yeast. The flour comes from various types of cereal grains, especially wheat (Qarooni *et al.*, 1989). In general, flours with extraction rates of 78% to 80% are preferred for the production of nearly all types of flat bread (Qarooni *et al.*, 1989).

Water is added according to the protein of flour and the variety of wheat. Most of flat bread flours have lower levels of water absorption and this makes them suitable for mechani-

cal production. Yeast is the most commonly used leavening agent used for bread production especially in Middle East flat bread. Salt is needed for flavor and increasing gas retention (Amr, 1988; Qarooni *et al.*, 1989, 1992).

Additional ingredients

Additional ingredients may be used for adding new flavours, improving the quality, increasing the nutritive value of bread and as processing aids which assist the bread-making process.

Sugar or honey

Sugar or honey may be added for improving the quality of flat bread in small amount. Sugar or honey provides a little more food for the yeast and will make the bread brown faster through caramelization and also gives more sweetness to the bread.

Milk

Milk is often added to impart attractive sensory properties.

Olive oil

Olive oil is the most traditional oil used in Mediterranean and Middle Eastern cooking. It is a source of oleic and linoleic acids. Oleic acid is monounsaturated and makes up approximately 55–85% of olive oil while linoleic is polyunsaturated and makes up about 9%. Mediterranean diet, which includes olive oil, is not only generally healthy, but that consuming olive oil can actually help lower harmful low density lipoprotein (LDL) cholesterol. Olive oil contains antioxidants that discourage artery clogging and chronic diseases. Polyunsaturated fatty acids lower both LDL and high density lipoprotein (HDL) levels in the blood, but they do not affect their ratio. Monounsaturated fatty acids on the other hand control LDL levels while raising HDL levels. No other naturally produced oil has as large an amount of monounsaturated fatty acids as olive oil, which mainly contains oleic acid (Frankel, 2011).

Eggs

Eggs are a good source of low-cost, high-quality protein. It is a particularly rich source of vitamins B12 and B2 and a useful source of folate. They are also a good source of the fat-soluble vitamins A and D and provide some vitamin E. Eggs contain many of the minerals that the human body requires for health, such as iodine, phosphorus, selenium, zinc and iron.

Dates

Dates or date syrup might be added to the formula of the bread. Health benefits of dates are significant as this fruit is rich in natural fibres. These natural products also contain oil, calcium, sulfur, iron, potassium, phosphorous, manganese, copper and magnesium which are advantageous for health. Dates are rich in several vitamins and minerals. It is said that one date a day is the minimum requirement of a balanced and healthy diet.

Other grains or cereals

Flours ground from cereal grains such as barley, corn, millet, oats, rice, rye and sorghum may be used as wheat substitutes for fortification to deliver greater nutritive value in flat breads. For example, barley is rich in manganese, selenium, phosphorus, copper, magnesium, iron, zinc, potassium, vitamin B6, thiamin, niacin, riboflavin and folate. Sorghum is rich in potassium and phosphorus and has a good amount of calcium with small amounts of iron, sodium, amount of thiamin, niacin and with small amounts of riboflavin.

Pastries

Other foods may be added to flat breads to make pastries which are consumed daily in the Middle East. For example, production of flat bread covered with a layer of spiced thyme and thyme mixture with olive oil, minced meat, spinach, cheese, pastırma, eggs and animal fat adds many other nutrients and confer other health benefits to bread.

Sesame

Sesame seeds are sometimes added to flat breads. The seeds are exceptionally rich in iron, magnesium, manganese, copper and calcium, and contain vitamin B1 and vitamin E. They contain lignans, including a unique content of sesamin, which comprises phytoestrogens with antioxidant and anti-cancer properties.

Black seeds

Black seeds contain numerous esters of structurally unusual unsaturated fatty acids and their chemical composition is very rich and diverse. Apart from their active ingredient, crystalline nigellone, they contain 15 amino acids (including eight of the nine essential ones), carbohydrates, fatty acids including linolenic and oleic, volatile oils, alkaloids and

dietary fibre, along with minerals such as calcium, iron, sodium and potassium. Other benefits for black seeds are being an antibiotic, anti-tumour, anti-inflammatory, anti-histaminic, antibacterial, anti-bronchial and immune-boosting agent (Ilaiyaraja & Khanum, 2010).

Green banana flour

The clear advantage presented by green banana (Musa spp.) flour includes a high total starch (73.4%); resistant starch (17.5%) and dietary fibre content (~14.5%). Due to the high content of these functional ingredients, regular consumption of green banana flour can be expected to confer beneficial health benefits for humans.

Flaxseed flour

While flaxseed, also known as linseed, is rich in protein, research suggests that its health benefits probably have more to do with its fatty acid and fibre profile (Valéria *et al*., 2010). The addition of flaxseed increases protein and fibre but also adds trace amounts of healthy, unsaturated fats. Flaxseed is emerging as one of the key sources of phytochemicals in the functional food arena (Valéria *et al*., 2010). In addition to being one of the richest sources of alpha-linolenic acid boil and lignans, flaxseed is an essential source of high-quality protein and soluble fibre and has considerable potential as a source of phenolic compounds (Oomah, 2001).

Dietary fibres

Dietary fibres have gained immense importance because of their constructive role in releasing sugars and the absorption of these sugars slowly in the intestinal tract; consequently, they reduce the severity of diabetes mellitus and are helpful in reducing blood glucose and cholesterol levels. Cereal bran or whole barley may replace up to 25% of the wheat flour, and the subsequent breads contain more ash, protein, dietary fibre fractions in comparison with control breads. Apple pomace, a by-product of the apple juice industry, is a rich source of fibre, pectin and polyphenols, and in view of the antioxidant property of pomace, it would play an important role in the prevention of some digestive-related diseases (Masoodi & Chauhan, 1998).

Cassava

Cassava flour has not been properly exploited for making bakery products mainly because it is rich in carbohydrates and low in protein content, contributing to poor dough characteristics (Shittu *et al*., 2007). Induced malting using amylolytic enzymes and pregelatinization through hydrothermal cooking were used to modify the textural and functional attributes of cassava flour, which was then blended with various cereal and legume additives as well as rice bran and used for making baked products. Cassava flour can also replace wheat flour and is used by some people with wheat allergies or coeliac disease (Shittu *et al*., 2007).

Food additives

Dough modifying or improver agents such as emulsifiers, gums, leavening agent, reducing and oxidizing agents have been employed in the formulation of a number of flat bread in automated bakeries.

Fortification of flours and bread

In the Middle East, bread has been a staple food for centuries, and its consumption is among the highest in the world. Therefore, fortifying wheat flour with the essential vitamins and minerals is seen as one of the most effective and inexpensive ways of improving diet (WHO/UNICEF/MI, 2003; WHO/EMRO, 2009). Fortification of flour and other cereals has played a significant role in delivering essential vitamins and minerals to people in the industrialized countries (IFM's Advisory Committee on Child Health and Nutrition, 2003). This has helped eliminate nutritional deficiencies and contributed to improved health and reduction in child and maternal morbidity and mortality. The levels of additions of many other ingredients are not identified in flat bread except for the level of additions advised by the World Health Organization.

Protein

Gluten is the protein backbone of baking. However, that does not mean that other proteins are not valuable for adding unique features to products, including healthful protein levels. Bakers will need to reformulate to address issues that arise when using protein sources other than wheat. The addition of eggs, milk powders and soy flour are used for functional rather than nutritional reasons. Flat bread is reaping the benefits of added protein for health and structural reasons. However, the largest area for almost all protein is still in product structure, baking quality, texture, shelf life, mouth-feel, colour and flavour. The most important protein supplements in flat breads are enumerated next.

Soy protein

Soy flour is the only consistent, economical protein resource currently available for fortification programmes of any significant size. Protein fortification in developing countries must be based upon soy flour until indigenous protein resources and processing industries can be developed. Fortifying wheat flour with full-fat soy flour in making bread can raise its protein content, balance essential amino acids and increase bread's caloric value. Such fortification, however, can adversely affect both rheological properties and baking quality of wheat flour (Tsen & Hoover, 1973; Hoover, 1974).

Whey protein

Whey proteins deliver three benefits: flavour, function and nutrition. From a nutritional standpoint, whey proteins balance the weaker value of proteins from grains and plants. Whey proteins are easily digested and offer the highest protein efficiency ratio (PER) of any protein with the exception of eggs. Whey proteins are high-quality proteins with a high biological value and contain high levels of branched chain amino acids, such as isoleucine, leucine and valine, which are lower in other plant-based proteins sometimes used in bakery products (Jooyandeh, 2009).

Egg protein

With their significant protein, vitamin and mineral content, and relatively low saturated fat content, eggs are a valuable component in a healthy diet. Eggs are an excellent source of protein. Egg protein is of high biological value as it contains all the essential amino acids needed by the human body. Eggs therefore complement other food proteins of lower biological value by providing the amino acids that are in short supply in those foods. 12.5% of the weight of the egg is protein and it is found in both the yolk and the albumen. Although protein is more concentrated around the yolk, there is in fact more protein in the albumen.

Legumes protein

Flat bread may be prepared from wheat flour with an addition of chickpea, pigeon pea and bean flours to improve the nutritive value and textural and organoleptic properties. PER of supplemented breads was significantly increased. Enrichment of Egyptian balady bread with decorticated cracked broad bean flour (*Vicia faba*) increases the essential amino acids and the protein efficiency ratio was found to be significantly greater (Abdel-Kader, 2001).

Vitamins

Flat bread flour is fortified with the following.

Thiamin (B1)

Thiamin has been included in cereal fortification programmes since their inception in the 1940s. Breads and cereals are considered 'thiamin donors' because they supply more than sufficient thiamin to metabolize the kilojoules they provide. Many studies suggest compliance with mandatory fortification of thiamin in bread-making flour at the level of 0.64 mg/100 g flour.

Folic acid

It is nearly impossible to get adequate intakes of folate from natural sources, particularly so because the natural folate has only 60% of the vitamin activity of synthetic folic acid. The level of folate in cereals is low, even in whole grain products (Hertrampf & Cortés, 2004). The surest way to get folic acid to the whole population is to add it to a food staple, with bread being the preferred vehicles particularly if it can be included with an existing or planned fortification programme. There is growing evidence that folic acid fortification will reduce the incidence of elevated homocysteine levels, considered a major factor in cardiovascular disease and strokes (Hertrampf & Cortés, 2004: WHO/EMRO, 2009).

Riboflavin (Vitamin B2)

Riboflavin has been part of most bread fortification programmes (WHO/EMRO, 2009).

Vitamin C

Ascorbic acid or vitamin C provides a number of important nutritional benefits but the one considered most desirable for cereal products is its ability to enhance the absorption several-fold of both native and added iron (WHO/EMRO, 2009). Ascorbic acid is routinely added to bread flour around the world at levels from 15 ppm to 100 ppm to improve the flour protein functionality during bread baking.

Minerals

Flat bread flour is fortified with the following.

Iron

Wheat flour is the only food vehicle that has been used extensively for iron fortification at national levels. Wheat flour fortification commonly assumed that it has contributed to the reduction in the prevalence of iron deficiency in countries where food iron fortification is mandatory. Because wheat is a dietary staple in middle East where iron deficiency is highly prevalent, the fortification of wheat bread is a logical intervention strategy in Middle East countries (WHO/EMRO, 2004).

Zinc

The dietary requirements for zinc and iron are similar. There levels of presence in cereals are similar and the potential for having their absorption inhibited by phytic acid usually means that if there is a dietary deficiency in iron there will be one for zinc as well. It is now being added to wheat flour in many countries. The levels added are typically 20 ppm to 30 ppm zinc (restoration levels). All zinc sources are white in colour so there is colour problem unlike the situation for iron. Studies in Turkey reported that bread fortified with zinc acetate had acceptable quality and was effective in preventing zinc deficiency in children (Saldamli, 1996; Romana *et al*., 2003; WHO/EMRO, 2009).

Calcium

Wheat and maize are very poor sources of calcium. Most of the calcium provided by cereal foods comes from the calcium containing ingredients that are added to bread and biscuits as functional ingredients, such as calcium propionate, calcium phosphates and whey. However, these ingredients are not normally added to bread in developing countries. Self-raising flour also contains high levels of calcium due to the addition of the chemical leavening ingredients. All other cereal products are very low in calcium. Flour can be fortified so that it contains up to 211 mg of calcium per 100 g of flour. This enrichment, however, provides only a modest amount of calcium in finished products such as bread. Calcium carbonate is added to flour at levels much higher than 211 mg without adversely affecting bread quality and this calcium is retained and well absorbed. The calcium sources used in cereal fortification are calcium sulphate and calcium carbonate. Both are white and bland in flavour. The other source of calcium are milk and other dairy products (Ranhotra *et al*., 2000; WHO/EMRO, 2009).

Iodine

The fortification of bread with iodine is being achieved by the addition of iodized salt which has resulted in a desirable increase in iodine intake, and the currently recommended salt fortification level seems reasonable (WHO/EMRO, 2009).

Flat bread developments

Flat bread is a traditional food produced by using basic materials with hard wheat flour sold and consumed in Mediterranean countries and elsewhere. Production of flat breads is often subsidized by governments. Developments in food industry have been applied in the production of flat bread but not to the same degree as many other types of foods, or even other types of bread in the world. This is partly due to the extra costs that additions would impose on the price of flat breads and the subsequent potential impact on the consumption of a food which is an important component of the diet of a very large number of consumers. More development studies are needed with respect to bread formulations and to identify the levels of addition to improve the nutritional value using such food products. These could include fortification with nutrients such as omega-3 fatty acids, vitamins and minerals. Improvements of flat bread quality and keeping quality are essential. Automation of flat bread making must be increased.

Summary

Flat bread is eaten with almost every meal in the Middle East. The manufacture of flat breads requires special characteristics in both the flour and the dough. Additional ingredients may be used in flat bread for adding flavour, improving the quality, increasing the nutritive value of bread and as processing aids which assist the bread-making process. Flat bread manufacturing is reaping the benefits of added protein for health and structural reasons. Flat bread flour is fortified with some vitamins and minerals. More development studies in flat bread production are needed.

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