Frekeh is an ancient and traditional whole wheat product that is generally produced from early-harvested, immature durum wheat. It is a scorched grain that is known for its desirable, smoky flavor. As an immature wheat, frekeh contains a high content of fructooligosaccharides, which are fructose-rich polymers with important biological functions. Depending on the time of harvest, it is possible to obtain a reduced phytic acid, high fiber frekeh.

An Analysis of Scorched Immature Wheat: FREKEH

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Fırik (in Turkish), frikeh, frekeh, or freekah is an ancient and traditional whole wheat product that is produced from early-harvested wheat at the milky stage using generally immature durum wheat (Triticum durum) and sometimes immature bread wheat (T. aestivum). The word is derived from afrakah (Arabic language), meaning grains in the spike are mature. It is a scorched, charred, or roasted grain that is generally homemade for domestic consumption or commercially produced by small-scale manufacturers. It is usually produced by roasting (scorching) the immature spikes on flames to burn off the awns and leafy material. Then the spikes are dried in the sun, threshed, the kernels separated from hulls, and cracked. The parching or charring gives the frekeh a unique, appetizing smoked flavor.

Frekeh can be classified in the same group with bulgur and pounded wheat (3,4), but the unit price of frekeh is two or three times higher than that of bulgur, pounded wheat, flour, and macaroni. Frekeh is a seasonable product and it is only produced during the early summer period. Therefore, a good production plan is required to ensure an adequate supply for ongoing production and marketing.

Frekeh is mainly produced in farms and villages in Anatolia (Turkey), Lebanon, Jordan, Egypt, Iraq, Iran, Syria, Mesopotamia, North Africa, and the Middle East between May and July, i.e., during the immature stage before harvesting. No large-scale industrial frekeh production facilities currently exist. It is estimated that the overall production is annually about 250,000–300,000 tons. Frekeh exports are generally made to European countries, especially to countries having large populations of Turkish, Arabic, Syrian, Jewish, Middle Eastern, and Armenian populations, such as France, Germany, Sweden, Spain, etc.

Origins as a Raw Material

Frekeh has been used as an ingredient for thousands of years and it even appears in the bible. Musselman and Al-Mouslem (13) present evidence that frekeh is referenced as roasted or parched grain. The Hebrew word for frekeh is kawlee, which means to scorch or roast slowly with shrinkage. In the widely used Van Dyke edition of the Arabic bible (1865), parched corn (King James Version) and roasted grain (New International Version) are translated into frekeh in the seven verses where it occurs (Leviticus 2:14, 23:14, Joshua 5:11; Ruth 2:14; 1 Samuel 17:17, 25:18; 2 Samuel 17:28). The Syriac text uses the Arabic cognate, froka.

Vallega (26) has suggested that diploid wild wheat or wild emmer (T. monococcum ssp. baeticum Boiss. emend. E. Scheim) was originally used for frekeh. According to Vallega (26), emmer was harvested green to prevent the shattering characteristic of the grain and to avoid losses due to the brittleness of the rachis. The harvest of immature wheat continued after durum wheat evolved, perhaps after harvesting green wheat from an accidentally burned field. The glumed grains may have been exposed to fire and roasted and eaten as whole kernels or ground into a meal of porridge or made into unleavened flat bread. Even today, grains of free threshing polyploid wheats are harvested while still green and roasted to produce frekeh all over the Near East and North Africa.

There is no archeobotanical or ethnological evidence that domesticated emmer [T. dicoccum (Schrank) Schübl.], in contrast to wild emmer, was used to make frekeh. Nesbitt and Samuel (14) show that parching was not used to prepare emmer wheat, making emmer a poor candidate for frekeh. If the glumes are burned in emmer, the grains could be damaged because emmer grains have thinner seed coats than other wheats.

Today, durum wheat (Triticum durum, a tetraploid) is favored for frekeh, but bread wheat (T. aestivum, a hexaploid) is also used. Durum wheat is most suitable since the best frekeh is made from the largest and hardest kernels. Generally, the Zenit and Diyarbakır spp. durum wheats are preferred.

The changes in kernel composition during maturation affect the properties of frekeh. It is generally accepted that frekeh processed from wheat harvested in late-milk-ripe to mid-dough-ripe stages are more appetizing than the ones processed at the full ripe stage, probably due to higher contents of free simple sugars (7,17). Frekeh is made when the culms and spikes are green. Determining the proper stage is critical. If too early, the grains will collapse; too late and the grains will not be green. Wheat is ready for frekeh preparation when some milky endosperm exudes from a grain bent sharply between the thumb and forefinger.
Processing Methods
Frekeh is generally homemade for domestic consumption or commercially produced by small-scale manufacturers (17). It is usually produced from immature wheat by two different processes: 1) roasting (scorching) the immature spikes on flames to burn off the awns and leafy material or 2) boiling them at atmospheric pressure (7) (Table I).
Wheat is cut or pulled in the morning then dried for 2–4 hours. Sheaves are placed on paved roads for burning, but bare ground or pieces of sheet metal are also used. During the season, numerous white clouds of smoke can be seen emanating from frekeh preparation sites in the afternoon.
Traditionally, the wheat was burned over the dried remains of other crops. Barley straw was used because barley harvest coincides with frekeh production. Fuel that is too hot or strongly scented is avoided. For example, frekeh is prepared at the same time that cumin (Cuminum cyminum L.-Apiaceae) is harvested, but burning cumin straw would flavor the frekeh. For this reason, cumin is not used in the scorching operation in Turkey.
Today, farmers use flamethrower-like devices fueled by butane tanks. Usually two people do the burning. One handles the flamethrower and the other turns the wheat with a pitchfork to expose green leaves and culms (Figs 1–2). All of the leaves, stems, and awns of the wheat are burned. When the glumes are charred and the tips of some of the grains are slightly blackened, the spikes are left to cool.
Within hours after cooling, the heads are threshed. Traditionally, this was done by flailing with poles. Today, the heads are collected into 40 kg sacks and fed into a threshing machine. The fresh frekeh is chewy, slightly sweet, and has a desirable smoky taste. After threshing, the frekeh is either bagged and taken directly to the market or it is dried.
Grain is dried in the shade to avoid bleaching. This is often done on large stretches of sidewalks in the city where grains are spread at night then gathered in the early morning before the sun can damage them (Fig. 3). Drying fresh frekeh reduces the weight by 40%.
High quality frekeh is plump and firm when fresh (indicating that it was harvested when the endosperm was maturing); slightly charred; green when dry; contains few remains of the paleas, lemmas, and glumes; and is free of stones and debris (Fig. 4). The latter is a serious problem when frekeh is made on bare soil or dried on sidewalks. For this reason, dried frekeh must be carefully cleaned before cooking (13,27).
Modernizing Production
As stated, in traditionally produced frekeh there are a lot of stones, ash, and foreign materials. Therefore, modern pro-

Table I. Sequence of steps required to prepare frekeh

<table>
<thead>
<tr>
<th>Operation</th>
<th>First day</th>
<th>Eighth to twelfth days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut green wheat stems (moisture content is between 35–50%)</td>
<td>Clean grains free of chaff and other foreign material.</td>
<td>Clean piece by piece frekeh using mortar, machines, or hand.</td>
</tr>
<tr>
<td>Spread and allow drying in the sun.</td>
<td>Obtain piece by piece frekeh using mortar, machines, or hand.</td>
<td>Store grains (frekeh) in sack for sale</td>
</tr>
<tr>
<td>Gather into loose bunches and burn with slow wind (heads laid into light to medium breeze. Spikes are inserted on the stone or cylindrical metal pipe by means of slope to separate burned spikes and stems. Same wind direction supplies homogeneous burning.).</td>
<td>Grinding or milling.</td>
<td>Grinding or milling.</td>
</tr>
<tr>
<td>Separate burned leafy material, ash, stone, soil, etc.</td>
<td>Course frekeh (for meals, pilaf, etc.).</td>
<td>Fine frekeh (for special meals).</td>
</tr>
<tr>
<td>Gather cleaned heads into heaps to dry by means of wind and sun. Thin layer should be supplied to prevent fermentation and rot. Moisture content is dropped to about 15%.</td>
<td>Flour (for feed).</td>
<td>Flour (for feed).</td>
</tr>
<tr>
<td>Data taken from Maskan (9).</td>
<td>Bran (for feed).</td>
<td>Data taken from Maskan (9).</td>
</tr>
</tbody>
</table>

Fig. 1. Scorching of immature wheat (13).  
Fig. 2. Winnowing and mixing of scorched wheat (13).  
Fig. 3. Sun drying scorched wheat (13).
duction methods of frekeh may be more suitable for today’s markets. Overall, there is no trademark on frekeh production and no company currently controls a majority of the industry. Therefore, this sector is suitable for new investors. Modernized procedures can be developed; drying can be performed with tunnel or tray dryers and parching or charring can be done using batch or continuous ovens. Wheat can be burned directly but in order to increase the capacity, liquefied petroleum gas can be used indirectly. Burning can be performed during wire belt conveying, then vibrational and rotary screens can be adapted to remove the burned leafy material. Air aspiration, cyclone, and stone control systems could also be used as a final step.

As seen in Figure 5, the charred and burned particles in the bulk product are a problem, but they can be separated using a color sorting system similar to bulgur (5). Another problem has to do with the different particles sizes, e.g., intact or broken kernels and foreign materials.

Consumption
The consumption of frekeh resembles that of bulgur (16). The consumer acceptability and quality of frekeh increase in relationship with kernel size and greenness. Therefore, durum wheat is better than bread wheat for frekeh production (5,7).

The quality of frekeh depends on the shape, plumpness, and greenness of the wheat and on the degree of parching, which should range from none to very light. Frekeh is a staple like rice, bulgur, and couscous. The ground or chopped grains are often boiled or steamed to be served with the meat of sheep or poultry (7).

When fresh, frekeh can be cooked with meat, like rice and bulgur in a pilaf. It is usually dried, however, to shorten cooking time. Frekeh is boiled in two parts water to one part dried frekeh. In Syria, frekeh is commonly used to stuff squash, eggplant, and grape leaves or it is boiled in chicken broth (13). Frekeh pilaf is a traditional dish in Anatolia and the Middle Eastern countries, consisting of frekeh, meat, tomatoes, salt, fat, and/or butter cooked together (16).

Health Benefits of Frekeh
Frekeh contains a number of significant beneficial substances, the quantity of which varies depending on when the wheat was harvested. For starters, immature wheat grains like frekeh contain a high content of fructo-oligosaccharides, which are fructose-rich polymers with important biological functions, such as antitumoral, immunostimulating, and prebiotic effects (11,20). These polymers disappear when wheat reaches physiological maturity (6). Fructo-oligosaccharides have also been shown to stimulate the absorption of several minerals in the intestine (12).

Table 2. The properties of frekeh obtained from different harvesting periods

<table>
<thead>
<tr>
<th>Harvesting date</th>
<th>Moisture content (% w.b.)</th>
<th>Protein (% d.b.)</th>
<th>Fat-content (% d.b.)</th>
<th>Ash (% d.b.)</th>
<th>Crude fiber (% d.b.)</th>
<th>Carbohydrate (% d.b.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 22, 1985</td>
<td>8.0</td>
<td>13.37</td>
<td>6.3</td>
<td>2.57</td>
<td>4.66</td>
<td>73.10</td>
</tr>
<tr>
<td>May 25, 1985</td>
<td>8.6</td>
<td>12.80</td>
<td>5.8</td>
<td>2.10</td>
<td>4.10</td>
<td>75.20</td>
</tr>
<tr>
<td>May 29, 1985</td>
<td>10.1</td>
<td>12.40</td>
<td>5.4</td>
<td>1.95</td>
<td>3.85</td>
<td>76.40</td>
</tr>
<tr>
<td>June 1, 1985</td>
<td>9.9</td>
<td>11.20</td>
<td>3.9</td>
<td>1.80</td>
<td>4.30</td>
<td>78.80</td>
</tr>
<tr>
<td>June 4, 1985</td>
<td>9.5</td>
<td>10.70</td>
<td>3.7</td>
<td>2.10</td>
<td>3.50</td>
<td>80.00</td>
</tr>
<tr>
<td>June 8, 1985</td>
<td>10.1</td>
<td>9.70</td>
<td>3.4</td>
<td>1.75</td>
<td>3.67</td>
<td>80.30</td>
</tr>
<tr>
<td>June 20, 1985</td>
<td>9.5</td>
<td>12.70</td>
<td>2.1</td>
<td>1.92</td>
<td>3.00</td>
<td>79.90</td>
</tr>
</tbody>
</table>

Average ± Std. dev. 9.39 ± 0.694 11.84 ± 1.151 4.37 ± 1.30 2.04 ± 0.237 3.87 ± 0.474 77.67 ± 2.43

Data taken from Hamit and Omari (8).
properties of immature wheat grains suggest that frekeh could be a good candidate for functional foods (6,22).

More specifically, several studies have examined the effects of maturation stages and cooking methods on the properties and composition of frekeh. The protein quality of parched immature durum wheat was also investigated by Takruri and coworkers (25).

Two samples of durum wheat cultivars (cvs. Duraking and Ege-88) at different maturation stages (13, 16, 19, 22, and 25 days post anthesis) were studied by Özka-ya and coworkers (16) using two different cooking processes: roasting (scorching) on flames and boiling at atmospheric pressure. In both cultivars and in both preparation methods, the hectoliter-weights and the 1,000 kernel weights increased steadily and significantly ($P < 0.05$) with maturation. The percent of small kernels decreased and the percent of large kernels increased uniformly in the frekeh produced by boiling and roasting from both cultivars during ripening. The ash contents of both cultivars decreased significantly ($P < 0.05$) with maturation. The Fe, Cu, Zn, Mn, Na, K, and Mg contents of both cultivars produced by both methods showed a downward trend within the period of maturation. However, Ca contents of the frekeh first showed a significant ($P < 0.05$) upward trend and then a downward trend during maturation. Significant ($P < 0.05$) reductions in thiamin and riboflavin contents also occurred with both cooking methods and in both cultivars with maturation. The first two stages of kernel development (13 and 16 days after anthesis) resulted in the highest sensory scores for the frekeh produced by both methods.

Özboy and coworkers (15) also investigated the dietary fiber and phytic acid contents of the same durum wheat cultivars (cvs. Duraking and Ege 88) at different maturation stages (13, 16, 19, 22, 25 days post anthesis). As most know, cereal foods are naturally rich sources of dietary fiber (28) and frekeh is no exception. Phytic acid, otherwise known as myoinositol hexaphosphate, is a naturally occurring compound formed during the maturation of seeds and cereal grains (29). Since it is believed that phytic acid has antinutritional properties due to its ability to chelate dietary minerals to humans and monogastric animals, the phytic acid composition of cereal products is of great interest. Özboy and coworkers (15) found that both the acid detergent and neutral detergent fiber contents of the frekeh produced from both durum wheat samples decreased significantly ($P < 0.01$) with maturation. Total P contents of the frekeh of both cultivars produced by both methods showed a significant downward trend within the period of maturation, while their phytic acid contents showed a significant upward trend ($P < 0.01$). As such, it was possible to obtain a reduced phytic acid, high fiber product from the wheats harvested at early stages of maturation (13 and 16 days after anthesis).

In a study including hard red spring and durum wheats, decreases in moisture and ash contents and increases in test weight, 1,000 kernel weight, and kernel size were observed as the maturation proceeded (24). Preston and coworkers (19) reported that kernel hardness, kernel weight, test weight, ash content, and milling quality were affected more than protein content. In another study, it was indicated that protein content of the kernel did not change significantly. However, changes were observed in the amino acid composition of proteins. Some of the amino acids increased while others decreased as the grain matured (18). It was also reported that zinc and phytic acid contents increased while the total P content had a tendency to decrease as the kernels matured (1).

In addition to these studies, Hamit and Omari (8) investigated the role of harvest time on frekeh quality in 1984 and 1985. They predicted that harvested early stage frekeh had higher protein, fat, ash, carbohydrate, and crude fiber content (Table II). In addition, they analyzed these frekeh based on sensory qualities and found that frekeh lose their acceptability when they approach the last harvesting stages (Fig. 6), i.e., the taste of frekeh turns to that of bulgur.

Hydration of frekeh was studied by Maskan (9) upon soaking at 20°C, 30°C, 50°C, and 70°C by the method of weight gain. It was found that maturation and processing affected the absorption characteristics of the wheat kernel. A significant effect of temperature on water absorption and volume change was detected. Frekeh absorbed more water than wheat and pounded wheat. The activation energy of water absorption by frekeh was determined as 9,696 kJ/kg mol (10).

Alfin and Çakmaklı (2) analyzed the characteristics of retailed frekeh found in markets in Syria. They determined that moisture (11.94% ± 0.696, w.b.), ash (2.074 % ± 0.131, d.b.), protein (12.20 % ± 0.316, d.b.), crude fiber (2.69 % ± 0.347, d.b.), and fat contents (2.68 % ± 0.306, d.b.) were similar for frekeh obtained from a number of different locations. However, the cooking properties (hardness, firmness), color, and sensory analysis of frekeh were analyzed and found to vary from location to location.

**Summary**

Frekeh is a whole wheat product usually harvested from immature durum wheat. It is a scorched or charred grain that is desired for its smoky flavor. While it tends to play a similar role as rice and bulgur in many meals, frekeh has some unique health characteristics that may increase its role as a functional food. As an immature wheat, frekeh is high in fructo-oligosaccharides. It is also high in dietary fiber and low in phytic acid, and it contains higher Fe, Cu, Zn, Mn, Na, K, and Mg content than fully mature wheat. While no commercial frekeh production facilities currently exist, the market is ripe for new investors, particularly those interested in a unique, healthy ingredient.
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References