# GIDA BİLİMLERİ VE MÜHENDİSLİĞİ KONULARI

Editör: Doç.Dr. Emine OKUMUŞ

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## İÇİNDEKİLER

*"Bu kitapta yer alan bölümlerde kullanılan kaynakların, görüşlerin, bulguların, sonuçların, tablo, şekil, resim ve her türlü içeriğin sorumluluğu yazar veya yazarlarına ait olup ulusal ve uluslararası telif haklarına konu olabilecek mali ve hukuki sorumluluk da yazarlara aittir."*

# EMULSION APPLICATIONS IN THE MEAT PROCESSING TECHNOLOGY

**Sümeyra Sultan TİSKE İNAN[1]**

## 1. INTRODUCTION

In the food industry, a significant proportion of foods are either completely emulsified or emulsified at some stage of the processing process. Examples of such products include salami, sausages, milk, cream, fruit drinks, soups, salad dressings, mayonnaise, ice cream, coffee bleaches, butter and margarine. The fact that the physicochemical and sensory properties of emulsion-type products are quite different has led to the diversification of raw materials and product techniques used in the production of these products. The quality of an emulsion-type foodstuff may vary depending on the appropriate concentration and variety of raw materials used in production and the appropriate processing, storage, transportation and use conditions. Examples of raw materials used in the production of emulsion type products are water, oil, emulsifier, minerals, acid, base, vitamin, coloring and preservatives (Ketenoğlu, 2010).

In this study, in addition to the structural properties of emulsion systems in the meat processing technology, the possibilities of using some plant and animal origin substances in production were examined as a result of the researches carried out in order to overcome technological problems together with the studies carried out in recent years to make emulsion type meat products healthier and more functional.

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## 2. MEAT EMULSION SYSTEMS

An emulsion is defined as a system in which two substances are held together in a colloidal structure, such as droplets or oil globules (dispersed phase), an immiscible in the other (continuous phase). In a true emulsion, the droplet or oil globule diameter is between 0.1 and 100 µm (McClemens, 2005). In addition to these two basic components, meat emulsions may also contain connective tissue fractions, carbohydrates, etc. The diameter of fat droplets in the disperse phase of a meat emulsion is greater than 100 µm; therefore, meat emulsions are considered to be more of a paste-like structure similar to a paste/pate. The dispersed phase in meat emulsions consists of fat globules, whereas the continuous phase is a matrix of myofibrillar proteins, flavorings, salts, additives and other components that can be dissolved in a gel-like environment. The main role of myofibrillar proteins in meat emulsions is as system stabilizers in the oil-water interphase. Myofibrillar fraction such as actin, myosin and actomyosin are responsible for many functional properties in meat processing technology. These fractions contribute to about 95% of the total water-holding capacity and 75 to 90% of the emulsifying capacity of meat, particularly its textural properties (Li-Chan et al., 1985). Although other emulsifying compounds are added at industrial level, myofibrillar proteins play an important role as the main emulsifying agent in meat products as well as forming part of the continuous phase. The ability of myofibrillar proteins to form an interface in the emulsion system varies depending on the pH, temperature, ionic strength and process parameters of the medium, as well as the characteristic molecular shape and form of the meat, the hydrophobic amino acid composition and so on. Proteases present in the emulsion medium can cause hydrolysis of proteins due to partial denaturation, giving them a structural emulsifying quality, and this hydrolysis can positively affect the emulsifying properties.

Garcia-Barrientos et al. (2006) reported that the use of endogenous enzymes and protease extracts from *Pseudomonas fluorescens* in a model emulsion system with pork and shark's meats was highly effective in forming emulsion and improving emulsifying properties. Proteolysis of myofibrillar proteins in the disperse phase can prevent the coalescence or creaming of oil droplets and thus stabilize the emulsion and increase its viscosity, while partially denaturated myofibrillar proteins at the oil-water interface can open up and cover a larger droplet area and increase the emulsion capacity. The functionality of meat proteins, including gelling ability and emulsifying capacity, has been reported to be species-specific (Jimenez-Colmenero and Borderias, 1983) and varies depending on whether the proteins originate from smooth or skeletal muscle (Borderias et al., 1983). Skeletal muscle proteins are known to have more effective gel-forming properties than smooth muscle proteins. This difference between smooth and skeletal muscles is mainly related to polymorphism and especially the molecular weight of the light meromyosin moiety of myosin in skeletal muscles varies both species- and muscle-specifically (Smith, 1988). Garcia-Barrientos et al. (2006) reported that this was also the case for pig and shark meats proteins. It was reported that the gelling ability and emulsifying capacity of pork meat was higher than that of beef and poultry meat, while fish muscles differed in these properties between species (Garcia-Barrientos, 2007).

## 3. FUNCTIONAL EMULSION TYPE MEAT PRODUCTS

Salt is an indispensable ingredient in the meat industry and salt has many basic functions in the meat products. The level of antimicrobial effect of salt varies depending on the concentration of use. If there is enough salt in the environment, it causes the death of microorganisms by drawing water from the environment through osmotic pressure. At the same time, it has a negative effect by disrupting the metabolism of the bacteria when salt ions penetrate the cell walls and enter the bacterial cell. Microorganisms are not equally sensitive to salt. It is reported that the acceptable salt content in ready-to-eat meat products is between 1.5-5.0%. In the production of meat products, 2-5% salt is generally used and although the antimicrobial effect of salt use at this concentration on microorganisms is not complete, the desired level of effect can be achieved by creating a hurdle effect with other additives and basic processes. Heat-treated emulsion type meat products and 20-25g of salt are used per 1kg of mixture and 25-32g of salt is used per 1kg of mixture in products produced as a mixture. Salt is used in higher concentrations in products that will be consumed in summer than in those that will be consumed in winter. The most important of the foreign substances that may be present in the salt used in production is magnesium, and if it is present in excessive concentrations in the salt, some undesirable color defects occur in the product (Öztan, 2005).

As a result of the changing views on dietary sodium intake in recent years, as well as the increasing incidence of cardiovascular and hypertension diseases, it has become necessary to carry out various researches on reducing the salt ratio used in the production of highly processed meat products. Undesirable negative changes such as protein extraction as a result of reducing the salt content of the products, reduction in the water holding capacity and hardness of meat gels, the emergence of different taste characteristics, the emergence of an undesirable soft texture as a result of excessive water loss in the products, as well as insufficient gel formation in the emulsion system can be completely removed if $Ca^{+2}$ independent Microbial Transglutaminase Enzyme (MTgase) is used. MTgase application, the desired amount of salt and phosphate ratios can be reduced according to the binding properties. Transglutaminase (Tgase) is an enzyme that catalyzes the cross-linking and polymerization of proteins by forming covalent links between protein molecules. As a result of the ϵ-(ɣ-glutamyl)lysyl cross-linking structure, low concentrations of NaCl and/or phosphates are used together or meat gels produced without these additives or meat in reconstituted minced meat. In parallel with the increase in the use of MTgase added to the emulsion paste, there is a significant decrease in the cooking loss values of the product and an increase in the hardness and chewability degrees, which are one of the textural properties. In order to provide functional properties to emulsion-type meat products produced at industrial scale, applications such as the use of some additives and some technologies are utilized in production. Tgase technology, which is one of these applications, the functional properties of food proteins are modified as a result of catalyzing some reactions within the foodstuff. As a result, the lysine in the structure of proteins is prevented from being adversely affected by various chemical reactions; lipids and/or lipid-soluble materials are encapsulated; temperature and water resistant film formation is provided; gelatinization can be performed without the need for heat treatment, elasticity and water retention capacity of the product are improved, solubility and functional properties are modified, and cross-linking of different proteins containing complementary essential amino acids is provided, allowing the production of foods with higher nutritional value. Although polymerization occurs as a result of Tgase-catalyzed protein cross-linking, in some cases proteins can gel without the need for heat treatment. When proteins in water-oil emulsion systems are treated with Tgase, cross-linking between protein molecules adsorbed on the surfaces of different droplets contributes to the aggregation of droplets. If the emulsion volume is high enough and the cross-linking is sufficiently extensive, the liquid emulsion protein is transformed into a stable emulsion gel. The emulsion gel induced by MTgase can then be subjected to heat treatment to form an emulsion system with a high elasticity gel.

Casein is one of the emulsifiers added to meat emulsions to increase emulsion capacity and ensure emulsion stability. As a result of the studies, it has been reported that cross-linking provided by MTgase application can be used to improve the stability of casein-based emulsions. To the methods developed for the utilization of low economic value trimming processed meat pieces, appearance and textural properties are improved and Tgase process can be applied to further increase the economic value of such meat. For this purpose, minced meat, Tgase and other ingredients are mixed and shaped, then packaged with pressure-resistant materials and used in the production of meat products such as hamburgers, meatballs and filling dough. Since such products are offered for sale by freezing, they are less in demand than other fresh and non-frozen products, and in this case, it is accepted that the use of Tgase enzyme in production can eliminate the need for freezing preservation. At the same time, the use of salt and phosphates, which have binding properties, can be minimized. Some studies have shown that caseinate is a good substrate for Tgase application. Tgase enzyme can catalyze the crosslinking of myosin with soy globules, casein and gluten. The combination of Tgase and caseinate has been reported to improve the water/oil retention capacity of the emulsion system. Caseinate gains a viscous structure when treated with MTgase, which acts as a gum in the emulsion system to hold the different fillers together. In parallel with the increase in the proportion of MTgase used, the water/fat binding power of meats with low economic value was also increased. The strongest binding level was found when 1% caseinate was used with MTgase. Caseinate used at higher concentrations negatively affects the binding strength of the system and weakens the binding strength by causing the formation of small gel pockets between the meat pieces.

Since phosphates have hydrophilic properties, they are widely used especially in the meat industry to improve product yield as well as textural and sensory properties of the products. Generally, diphosphates and triphosphates are used in the meat industry and according to the Turkish Food Codex (TFC), allowed to be used at a rate of 0.5% in meat products. When this situation is evaluated from the consumer point of view, it is stated that there is an evolving opinion in favor of using less chemical additives in food production. It has been concluded that modified proteins with 3% Tgase application in products with reduced phosphate usage rate can improve textural properties. It has even been reported by some researchers that meat pieces can be bonded together without the use of phosphate and salt thanks to the application of MTgase. As a result of the use of transglutaminase enzyme, products with high water holding capacity can be produced without using gelatin in production. Gelling of muscle proteins contributes to the improvement of the stability of water-fat emulsions and the textural properties desired in further processed meats. In studies on the binding and textural properties of gels formed using beef, it was reported that the water holding capacity of beef homogenizate treated with MTgase increased significantly. It was reported that treatments containing Tgase at 0.5% concentration had a higher moisture content than those without Tgase.

Spices have an important place among the additives used in the production of meat products with functional properties. Since some of the countries, especially Türkiye, are not very sufficient in terms of spice agriculture, many spice varieties are supplied by exporting. The amount of spices that should be used in the production of meat products is generally 2-3%. Although the spices used in the production of many products such as cumin used in the production of sausage and buy herb used in the production of pastrami have the feature of being the basic ingredient of that product, as a result of not using these spices, the desired taste and aroma in the product cannot be revealed. It is known that spices have a stimulating effect on the glands in the living organism. With this effect, which occurs thanks to some of the active ingredients in the spices, digestion is easier and this type of foods cause less discomfort in the stomach than others. In order to achieve an ideal flavor harmony in the production of a product, it is necessary to reduce the amount of salt compared to the amount of spices to be used, thus enabling the production of healthier foods with higher nutritional value. To the antimicrobial substances, essential oils and aromatic components in spices, the taste, shelf life, color and digestibility of the product can be further improved. Although the inhibitory effect of spices varies according to the variety, it has been reported that sage, rosemary and garlic have strong inhibitory effects; allspice and black pepper have inhibitory effects; coriander, cloves, nutmeg, cardamom and cumin have weaker inhibitory effects. Some spice varieties have antioxidant properties and red pepper is known to have an antioxidant effect on fats and it is also stated that it facilitates the color formation in the product thanks to the ascorbic acid it contains. It has been reported that if the spices are used in production in large pieces without grinding, the cross-sectional surface appearance improves even more, and a compatible appearance is provided with the use of grain spices such as whole black pepper, mustard seeds, pistachios. The most preferred spices for use in the meat industry are as follows;

- The leaves of sage are used and the active ingredients are thujuen, campfer and cineole. It has antioxidant effect.
- The leaves of rosemary are used and the active ingredients are pinene, cineol and camphor. It has an antioxidant effect and is especially used in raw (non-heat-treated) products.

- Karaman cumin is a spice marketed under the name of cumin in general. The active ingredients are carvone, limonene, carveol, dihydrocarvone and dihydrocarveol. It is used in the production of many meat products, especially semi-dry fermented sausages, sucuk ect. (Öztan, 2005).

## 4. CONCLUSION

The demand for meat and meat products is increasing in many parts of the world, especially in Türkiye. As a result of the claims made in recent years for the consumption of emulsion-type meat products, many ingredients, additives and different technological applications are utilized in order to make these products healthier and more nutritious. These applications have contributed to the production of meat products with more functional properties by reducing the content of saturated fatty acids, salt, cholesterol, energy and chemical additives to the lowest levels. There is a need to develop such applications and related technologies, as well as the need for further studies in the scientific field. Meat snacks are very popular and occupy an important place in the food basket, especially due to their convenience, nutritional properties and meal replacement. Several technological interventions have been carried out to develop meat snacks with increased nutritional and functional value as well as longer storage life at ambient temperature.

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# THE BAKING INDUSTRY PRODUCTION PROCESS

**Engin YARALI[1]**

**Alican TAŞÇIOĞLU[2]**

## 1. INTRODUCTION

Consumption of bread and other bakery products has been expanding with the progress of time, such that it has grown to an established and integral staple portion of the diet of the populace. Now globally, bakery market is among the largest of processed food industries consisting of wide product categorization making it the biggest subzone in the food industries. Additionally, bread is produced around the world in a wide variety of sizes, shapes, textures and flavors. The conversion of agricultural raw material from batter/dough to the product of the final consumableform is intricate (Jerome et al., 2019). Despite their different characteristics, a literature review shows that the quality of bread and bakery products is mostly influenced by the three major stages in the production chain: milling, mixing, and baking (Pagani et al., 2014; Arepally et al., 2020; Cappelli and Cini, 2021).

Bakery establishments in the food sector are closed, noisy and smelly environments and employees usually perform their jobs standing up. In the production process, there are many critical points to be considered from raw material input to

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finished product output. Production stages generally consist of preparation of raw materials and additives, flour sifting, mixing, cutting, shaping and baking. Various bakery products have been developed depending on the different baking procedures and ingredients used in each region or culture, nevertheless, the main ingredients are flour, water, yeast, and salt. Bread is considered a solid, heterogeneous, and unstable foam, constituted by crust and crumbs, whose main components are starch granules displayed in a continuous protein matrix. The quality of the raw materials and food additives used in production affects the quality of the final product. Process additives used in production are substances that are not consumed as food alone. They are substances used for a specific technological purpose and whose residues do not pose a health risk and do not have a technological effect on the final product (Anonymous, 2012c; Bredariol et al., 2020).

## 2. CHARACTERISTICS OF THE WORKING ENVIRONMENT

### 2.1. Doors and Windows

Doors and windows in businesses should be made of materials that are resistant to acid, alkaline, rust, and easy to clean and maintain, and windows and doors in the production area should be kept closed (Yücel and Özcan, 2010; Anonymous, 2012c). Windows should be constructed to prevent dirt accumulation and should be light colored and they should be installed at least 1.2 m above ground level (Lelieveld et al., 2016). The inner and outer parts of the windows should not be used as shelves. For this reason, the inner threshold should be inclined by 20-40° and the outer threshold by 60°. Window glass located near work areas, raw materials or semi-finished materials must be tempered (Canja et al., 2013; Nazlı, 2017).

Doors can be cleaned, disinfected when necessary, and should be made of smooth and non-absorbent material (Anonymous, 2017). Doors should be made resistant to hard impacts, long-lasting, rust-free and dust-resistant. It should be designed in such a way that it does not absorb oil or food particles and is not a shelter for harmful insects (Lelieveld et al., 2016). Doors in production areas should be of sufficient width, and if possible, automatic or two-way operation types should be chosen. Air curtains should be used as a precaution to prevent the entry of pests such as flies, mice, dust, etc. (Uğur et al., 2003).

### 2.2. Ground

Ground coverings must be durable, anti-slip, easy to clean and suitable for disinfection. Coatings must be waterproof, wear-resistant, washable (Anonymous, 2012c). Unsuitable ground make it difficult to maintain hygiene standards, increase the risk of accidents and increase sanitation costs (Göktan and Tunçel, 2014). Cracked, rough and broken surfaces are difficult to clean and cause dirt accumulation over time. Due to these disavantages, waterproof, easy-to-clean materials such as marble, epoxy and similar resins and ceramics should be preferred on the floors (Nazlı and İzgi, 1997). There should be no dead spots on the corners and edges, and the corners should be rounded in a concave shape (Kalkışım et al., 2012; Göktan and Tunçel, 2014). Floors must be resistant to the operations to be carried out in the environment, the cleaning materials and methods used, heavy loads and the movements of the trolleys. Floors should have a suitable slope to ensure adequate drainage (Anonymous, 2017).

### 2.3. Ceiling

The ceiling height should be suitable for the product produced and the tools and equipment used. Ceilings and ceiling structures should be designed in such a way that they do not allow the formation of mold and the accumulation of dirt as a result of moisture condensation. It should be built of water-resistant material so that there are no space in the structure and prevents the entry of dirt, dust and pests. Ceiling surfaces should be smooth, there should be no paint, plaster pieces or poorly bonded ceiling fixtures on the surface. Ceiling fixtures such as fan and fluorescent lamps must be properly protected to prevent contamination of food. Ceilings should not have wiring or open electrical points that could cause the movement of insects or the accumulation of dust and dirt. Maintenance of ceilings should be done regularly (Anonymous, 2017; Göktan and Tunçel, 2014; Kalkışım et al., 2012).

### 2.4. Wall and Partition

Wall surfaces should be smooth, easy to clean, washable and disinfectable. It should be waterproof, does not absorb dirt and oil, should be made of light-colored material and should be resistant to corrosion. There should be no cracks or debris on the walls. Colors that show light and dirt on the walls should be preferred (Baş, 2006; Anonymous, 2012c; Canja et al., 2013). If tiles are planned to be used, the tiles to be used should be non-porous and there should be no cracks/pits on the surface. Stainless steel plates or pipes should be fixed to the walls in order to prevent damage to the walls and the formation of paint and plaster particles during the movements of the trolleys (Anonymous, 2017). Electrical cables located on the wall surface must be protected by a piping system. All pipe systems passing through the walls should be hidden, existing pipes should not be attached to the wall, and a distance of at least 4 cm should be left between them (Anonymous, 2008a).

### 2.5. Lighting

Lighting in businesses is a very important issue in terms of food safety and occupational safety. Good lighting is necessary for adequate inspections at critical control points and for determining the factors that cause pollution. Daylight lighting is the ideal one. However, in addition to daylight, artificial lighting such as electric lamps and fluorescent lamps can also be used (Topal, 1998). The light in the production area should be given from a high and sufficient level, and should be of equal intensity in all areas. Lamps used for lighting should be protected and thus physical hazards that may occur as a result of breakage should be prevented (Nazlı, 2017).

### 2.6. Flour Storage

Flour storage should be separated from other sections by walls, bright and airy, large enough for storage according to the daily capacity of the oven, and at least 50 $m^2$ (Anonymous, 2018). Flour storage should be placed in the technological flow area to ensure a functional connection with the production area. In these areas, suitable temperature and humidity conditions, good ventilation and lighting should be provided, and temperature and humidity meters should be available. Flour bags should be placed on plastic pallets at a height of about 10 cm from the floor, easy to clean, disinfectable. Cleaning and packaging materials should not be stored in the sections used as flour storage. If other raw materials are to be stored in the same area as flour, each raw material should be stored in different stacks or placed on separate shelves. It is recommended that raw materials that can absorb foreign odors should be stored in separate rooms or using a package with the possibility of isolation (Erkan, 2009; Canja et al., 2013).

# 3. RAW MATERIALS AND FOOD ADDITIVES USED IN PRODUCTION

## 3.1. Flour

Flour generally contains protein, starch and other carbohydrates, ash, fat, water and small amounts of vitamins, minerals and enzymes. Wheat flour is most commonly used in bread production, as well as rye, einkorn and barley flours. Wheat is unique among the cereals in that its flour prosesses the ability to form a dough when mixed with water. In addition, wheat doughs have the ability to retain the gas produced during fermantation or by chemical leavening and thus give a leavened product. These two characteristics of wheat flour doughs are responsible for our preference for wheat products (Hoseney, 1994). Flours obtained from wheat in cereals; It is very important in terms of obtaining a light, delicious and rising bread. Gliadin and Glutenin are the main proteins in wheat flour, and these proteins show different properties when they absorb water (Bushuk and Rasper, 1994).

Glutenin has a rubbery structure, while gliadin is viscous and sticky. Gluten structure is formed by the combination of these two proteins by absorbing water. Gluten keeps the $CO_2$ gas created by the yeasts during fermentation and allows the dough to rise (Ergönül, 2007). Flour quality is estimated by the measurable physical, chemical and technological properties of flour and dough. The flours used in bread making are obtained from strong and hard wheats. Strong flour expression is related to the protein quantity and quality of flour. In bread production, flours containing high levels of gluten obtained from hard wheat varieties (HRW: hard-red-winter, HRS: hard-red-summer) of *Tr. aestivum* species are preferred (Elgün and Ertugay, 1995; Kalkışım et al., 2012).

One of the biggest problems in flour used as raw material is physical hazards. In flours that are not properly sifted, stone, soil, wood and metal fragments, glass shards, sack ropes, straw, crust pieces, and insect residues can be found (Özkaya and Özkaya, 2005; Ergönül, 2007). In addition, weed seeds that grow spontaneously in the field can mix with the wheat during harvest and can pass into the flour if it is not properly cleaned. Since some of these weed seeds are poisonous, they can have a negative effect on human health. Another danger encountered in flour is mold growth. Although molds can be eliminated by high temperatures applied during the bread baking phase, mycotoxins, which are secondary metabolites synthesized by molds, can continue to exist in the final product (Özkaya and Özkaya, 2005; Kalkışım et al., 2012).

### 3.2. Water

The water used in production is effective in dissolving salts and sugars in the dough and dispersing yeast cells, and is also important for the hydrolysis of starch and sucrose. Water added to flour activates enzymes, enables the formation of new bonds between macromolecules, and changes the rheological properties of the dough (Gil et al., 1997). Without water, dough cannot form and therefore viscous flow properties cannot occur. In addition, many of the reactions that occur during fermentation cannot occur (Hoseney, 1994). The amount and quality of water used in production is very important. In production, microbiologically safe, free of foreign microorganisms, without chemical pollution such as pesticides, medium hardness and drinking water should be used. The water used in the enterprises should be analyzed at routine periots. In addition, the water used should not contain bad odor and flavoring substances, and should be free from turbidity substances (Kalkışım et al., 2012).

### 3.3. Salt

Salt used in bread production, it should have a granular structure that will not cause clumping, should not contain foreign substances and microorganisms, should be clean, bright and white, should have high water solubility, and should not contain unwanted minerals. The salt used in bread production should be table salt and should be taken in packaging with a certificate of analysis (Ergönül, 2007; Kalkışım et al., 2012). Salt not only gives taste and flavor to the bread, but also improves the physical properties of the dough and has a gluten-strengthening effect. Salt makes dough stronger, presumably by shielding charges on the dough proteins (Marques et al., 2012).

### 3.4. Yeast

Rising in bread products is achieved in three ways, these are; biological rising with yeast, chemical rising with baking soda (sodium and ammonium bicarbonate), and physical rising with steam and air. Rising products; it has a large volume, structurally elastic internal structure, easy separation when cutting, and light in appearance. Yeast is one of the fundemantal ingredients; its major role is to convert fermantable carbohydrates into $CO_2$ and ethanol. The gases resulting from this transformation determine the production of a light or leavened loaf of bread. Yeast also has a very pronounced effect on the rheological properties of the dough (Hoseney, 1994). Artificial yeasts (*Saccharomyces cerevisia)* produced by using technology are used to ensure the rise of products such as bread. Fresh, dry and instant yeast is produced in yeast factories using modern technologies (Kalkışım et al., 2012). The amount of yeast used in production should be calculated correctly and the most appropriate temperature and pH values should be provided for the yeast to growing in the dough (Kalkışım et al., 2012; Aydın, 2016). The temperature of the refrigerator where the yeast is stored should be constantly checked, recorded, and the cleaning of the dough mixing tank should be done carefully. Baker's yeast should not be kept in heat, light and humid environments that will adversely affect its properties, and should not be stored with food and/or non-food substances that emit bad odors (Marques et al., 2012).

### 3.5. Other Additives

Various additives and decor materials are used in the production of products such as bread in order to increase the quality by eliminating some defects and deficiencies arising from the composition and properties of flour, and to increase the efficiency of the enterprises by saving time and labor. These substances must be used in accordance with the relevant laws and regulations. The decor materials used are the decoration materials used to make the product look more aesthetic. In addition to the basic ingredients, utilty components called additives are also used when preparing bread dough. The reasons for the use of additives are generally to increase the nutritional value, to extend the shelf life, to provide textural changes (such as pore structure), to provide a desired taste change, to prevent the development of disease-causing microorganisms and to beautify the appearance (Anonymous, 2012a). In general, additives used in production are antimicrobial agents, emulsifiers, sweeteneers, oxidants, enzymes, surfactans, gelling agents, milk and dairy products, malt and soy flour (Anonymous, 2012b).

## 4. PRODUCTION PROCESS

### 4.1. Sifting Flour and Mixing

Before mixing the bread dough, the flour to be used must be sifted. Elimination process; It is made in order to separate foreign substances such as rope, sack fiber, etc., which may be found in flour, and to separate flour particles from each other (Anonymous, 2012b).

The flour particles obtained from hard wheat are dense and water penetrates slowly into the particles. The only driving force for the water to move to the center of the particle is diffusion, which is slow. Mixing, however, provides an additional mechanism. A new particle layer forms against the excess water in the system as the hydrated particles rub against each other, the mixer chamber or the mixer blades. As this process is repeated over and over again, the flour particles gradually become completely moist. As more and more of free water is used to hydrate the protein ans starch, resistance of the system to extension is increases progressively (Hoseney, 1994). The mixing process ensures that flour, water, salt and yeast are mixed homogeneously. While the dough is mixed, the air between the flour particles and raw materials is distributed in the dough. These air bubbles, which are effective in the rise of the dough, continue to enter the dough with their mixing movements. (Autio and Laurikainen, 1997; Anonymous, 2012b). To obtain a dough of the desired structure, flour must be mixed with the required amount of water. The internal temperature of the dough coming out of the mixing should be 23-24 $^{o}$C for the winter months and 21-22 $^{o}$C for the summer months (Giannou et al., 2003; Aydın, 2016).

The optimum mixing time in production is 20-25 minutes. The dough, which has been mixed sufficiently, is easy to process, has a high gas holding ability, has a large bread volume and good bread qualities. The dough obtained as a result of insufficient mixing shows a sticky and inelastic structure. These doughs are difficult to process and the volumes of the bread obtained are small, the pores inside the bread are large, and the inner color of the bread is dark. In case of excessive mixing, the breads obtained are small in volume, tight inside the bread, light in color and thin pores (Anonymous, 2012b; Kalkışım et al., 2012)

### 4.1.1. Considerations in Mixing

In dough made with wheat flour, approximately 80% of the water given to the dough is absorbed at the end of the mixing process. However, this ratio may vary according to the water holding capacity of the flour. The free water is located on the outer wall of the gas bubbles in the gluten structure. Immediately after mixing, these water films; It causes the stickiness of the dough, creating an extensible structure and releasing the dough itself. In the next waiting phase, the dough loses its stickiness as a result of gas formation and becomes tighter. The amount of water in the dough is also; It ensures the processability of the dough, the pore structure in the dough and the maturation of the dough (Anonymous, 2012b).

The surface of a dough mixed to its consistency is smooth and does not stick to the hand. Mixing time; It varies according to whether the flour is weak or strong, the flour yield, the pH of the dough, the tightness of the dough, the number of cycle of the mixer, the type of mixing machine, the amount of dough and the additives used. For example low-protein flours (<12% protein) require longer mixing times simply because they contain less protein. Protein content above 12% does not affect mixing time. Additionally, certain chemical agents, particllary reducing agents such as cysteine and reletaed compounds, are quite effective in shortening mixing time. This reagents apperantly work by breaking disulfide bonds in the glutenin proteins, thus making the proteins smaller. These smaller proteins hydrate more easily and thus lead to shorter mixing times. (Hoseney, 1994; Anonymous, 2012b).

If salt is added from the beginning in fork type mixers, which are generally used during the production phase, it becomes difficult to knead the dough. In this case, salt increases the need for mixing by strengthening the flour during mixing. If the dough is stabil in manual controls, salt should be given at this point. The addition of salt should not be delayed, especially in weak flours. Otherwise, there may be excessive decomposed in the dough (Anonymous, 2012b).

Fermentation begins immediately after mixing the dough with the yeast. Yeast; It produces carbon dioxide by using sugar in an oxygen-free environment. The time elapsed between preparing and baking the dough must be carefully adjusted so that the yeast can multiply. The yeast should be given in the form of a solution (syrup) and when the salt is well mixed with the dough (Anonymous, 2012b).

There is an increase in dough temperature during the dough mixing process. Taking into account the type of mixer used and other factors, it is necessary to calculate the flour and water temperatures well in order to obtain the dough temperature at the desired temperature. The temperature of the mixed dough should be 22-23 ºC on average (Anonymous, 2012b; Marques et al., 2012).

### 4.1.2. Dough Making Methods

Straight dough system is called 'Direct Mixing. In such a system, all the formula ingredients are mixed into a developed dough that is then allowed to ferment. During its fermantation, the dough is usually punched one or more times. After fermantation, it is divided into loaf-sized pieces, rounded, molded into the loaf shape and placed into the baking pan. The dough is then given an additional fermantation to increase its size. After reaching the desired size, it is placed in the oven and baked. In the straight dough system, the fermantation time may very quite widely, from essentially no time to as long as 3 hr. In general, straight dough bread is chewier than bread made by other techniques; It has coarser cell structure, and it is generally considered to have less flavor. With larger bathces, its time sensivity can be a problem in this system; if the first of the batch receives optimum fermantation, the end of the batch becomes quite overdeveloped (fermented too long) (Hoseney, 1994; Anonymous, 2012b).

Indirect dough making method is called the 'Delayed Salt Method' or the 'İspir Method'. It is a mixing method in enterprises where fork mixers are used. This method includes the following steps: Flour, water and additives are added, mixing with a mixer for 30–35 minutes and then salt is added, mixing for 5 minutes. Yeast is added, mixing for 5 minutes, resting (mass fermentation) for 15-20 minutes and cutting, weighing, and other processes are started (Anonymous, 2012b).

In making sponge and dough procedure, part of the flour (approximetly two thirds), part of the water, and the yeast are mixed just enough to form a loose dough (sponge). The sponge is alowed to ferment for up to 5 hr. Then it is combined with the rest of the formula ingredients and mixed into developed to dough. After being mixed, the dough is given an intermediate proof of 20-30min. So that it can relax, and then it is divided, molded, and proofed as is done in the straight-dough procedure. This procedure gives a soft bread with a fine cell structure and well-developed flavor. One of the great advantages of the sponge and dough procedure is its tolerance to time and other conditions (Hoseney, 1994).

Continuous mixing method has been developed as an alternative to the traditional bread production method mentioned above. Generally, liquid yeast is used. The enterprises where this type of production is preferred are high-capacity factories.

These enterprises are a complex system consisting of tanks where liquid yeast is prepared, continuous mixing unit, fermentation room, weighing, shaping unit, and moving belts. This method includes the following steps; liquid yeast is prepared and dough is obtained by adding water and additives used in production to flour. The dough is sent to the next stage in a controlled manner and under certain pressure. The dough is taken into molds with a special unit and sent to the baking unit (Anonymous, 2012b).

In the short-term dough making method, there is no need for the dough to ripen with effective mixing. The dough obtained at the end of mixing is processed immediately. In traditional production methods, less water is given as the dough will soften with the enzymes working on starch and gluten during fermentation. When this method is used, since there is no fermentation time, more water is added to the dough at the beginning. Since the fermentation time is shorter in the final stage and production stages, $CO_2$ loss is less. Weighing errors caused by fermentation time are reduced. In addition it also has some disadvantages, these are; high yeast usage is required. Since a very effective mixing is used, the dough temperature can be high and ice should be used to prevent this. More oxidant substances should be used for prevent to oxidation. Additon, the investment cost is high (Anonymous, 2012b).

### 4.2. Dough Cutting and Shaping

Doughs are prepared for shaping by cutting them on machines or by hand. Hand-cut dough is weighed on scales at the appropriate weight. Devices called cut-and-weigh are used as machines and such machines work according to the volume measure. The dough is cut by adding the loss of baking to the weight of the bread in the cooked state, which is considered to be offered for sale. In cut-weighing machines, the dough is placed in the funnel at the top of the device and an estimated piece is cut and the weight of the cut piece is determined by weighing it on the scale. In order for the dough whose weight is measured to reach the appropriate weight, the volume is adjusted with the handwheel of the device. When the desired weight is achieved, the setting is kept constant and the cutting process continues. However, with the development of technology, machines that perform this process automatically have also started to be used (Anonymous, 2012a).

The process of shaping is applied to the dough that comes out of the cut-weight machine in the appropriate weight. Although it was done by hand before, shaping machines are preferred today. During shaping, the dough is ventilated and the resulting carbon dioxide gas is removed from the environment and the yeast is multiplied. Although the machines used in shaping vary in terms of operability / model, they are used to make shapes called round (loaf) and stick (baton-baguette). The shaped dough is placed in the mold, greaseproof paper or pan where it will rise. Bakery breads, which are made by placing them directly in the oven, are placed in molds and cloth sprinkled with flour to rise after the shaping process is finished (Anonymous, 2012a).

### 4.3. Properties of Yeast Used in Production and Fermentation Conditions

The dough, whose mixing process is completed, is rested by mass fermentation, intermediate fermentation and final fermentation processes. Fermentation is a biochemical event that begins with the reaction of certain yeasts with the product under specific conditions (Aydın, 2016). The chemical compounds formed during fermentation ensure the ripening and rising of the dough and have an effect on the formation of taste and aroma (Kalkışım et al., 2012). The time from the production of the dough to the cutting of it into pieces is defined as mass fermentation (10-15 min.) (Ünal, 1997). Intermediate fermentation is when the dough is rested to allow it to recover (Anonymous, 2012b). Final fermentation refers to the time from the dough to the time it is cooked. The dough is generally kept at 27-30°C and 75-80% relative humidity for 30-60 minutes in the final fermentation. This period varies depending on the volume of product (Ergönül, 2007; Kalkışım et al., 2012).

The most important event that occurs in the dough during fermentation; It is the formation of $CO_2$ and alcohol by yeast. The $CO_2$ formed during fermentation accumulates in the dough and rises, and the alcohols, aldehydes, ketones and organic acids formed gain the appetizing characteristic taste and aroma of the bread. Another task of yeast is to improve the physical structure of the dough. Thus, the elasticity of gluten increases and the dough gains a structure that better withstands and retains the pressure of $CO_2$ gas accumulated in its structure (Anonymous, 2008b).

Yeast is a versatile organism; it can ferment under either aerobic or anaerobic conditions. The early stages of fermantation are aerobic process, whereas bread fermantation is an anaerobic process. The oxygen in a dough is rapidly consumed by the yeast and becteria as fermantation starts. Thereafter, the fermantation is anerobic unless we add oxygen to the system. As $CO_2$ is produced, the pH decreases and the aqueous phase becomes satureted with $CO_2$. As fermantation proceeds, it is customary to punch or remix the dough, depending upon which baking system is being used. Remixing splits gas cells and contributes to the production of smaller cells. In this sense, a large amount of $CO_2$ passes into the atmosphere, but the important part of the process is the creation of new gas cells. Another important benefit of punching or remixing is the mixing of the dough ingredients. Yeast cells have no mobility in the dough and therefore are dependent on the sugar diffusing through them. As fermentation progresses, diffusion distances increase, thus decreasing sugar concentration and fermentation rate. Punching or remixing recombines the yeast cells and fermentable sugars, affecting dough rheology in addition to the yeast's ability to produce gas. (Hoseney, 1994).

### 4.4. Baking and Cooling

Before the dough is put into the oven, it is necessary to do some operations to bake the bread with the desired feature and quality. These processes are; sprinkling water on the dough, scoring the top of the dough (throwing a knife), sprinkling water on shovels and pans, and adding steam to the oven (Anonymous, 2008b). Some, but not all, of the fermented dough must be wetting before being put in the oven or baked. The process of throwing a knife into the dough is important in terms of controlling the shaping of the bread. In addition, for bread dough to be baked in the oven, corn flour or flour should be sprinkled on the shovel used to put it in the oven. For pan breads, before the dough is placed in the pan, the pan should be very thinly oiled or floured in a thin layer with cornmeal. Finally, steam should be supplied into the hot oven when the bread is first in the oven. The steam sprayed into the environment during the first cooking period prevents the crust from drying out and helps it gain volume (Anonymous, 2008b).

The last of the bread production stages is the baking process, in which the dough acquires a light, porous, easily digestible and delicious structure under the influence of heat. Most of the compounds that make up the taste and aroma of bread are formed during baking. During this process, in which the dough is transformed into bread, a number of simple and at the same time highly complex physical, chemical and biochemical reactions of the dough components irreversibly occur. Things start to happen rapidly as the relatively cool dough is placed into to hot oven. Once the dough enters the oven, the surface of the dough exposed to the oven atmosphere immediately begins to form a crust. When the surface of the dough continues to dry rapidly, a crust continues to form. Subsequently, the moisture on the surface of the dough evaporates very quickly as it comes into contact with dry, high-temperature air (Anonymous, 2008b).

During the first few minutes in the oven, the dough expands iz size rapidly. This is called the oven-spring. Several factors are responsible for the oven-spring. Gases heat and increase in volume; $CO_2$ becomes less soluble as the temperarue raised; yeast becomes quite active as the temperature is raised (as long as it it does not get too high); and other materials (for example ethanol-water mixtures) are vaporized. Generally, the oven-spring stage lasts less than 8 min; the remaining baking time is to ensure that the center of the loaf approaches 100 $^{o}$C. The later stage of baking are when all the bwoning occurs. Browning occurs veary late in the system because it takes place much faster in a dehydrated system. The browning on the bread surface results from a Maillard-type reaction. Sucrose is a nonreducign sugar, but yeast contains invartase, which rapidly produces glucose and fructose, both of which are reducing and brown quite readily. Caramelization is occasionally mentioned as a mechanism of browning in bread; however bread produced by chemical leavening (where there is nothing to convert sucrose to reducing sugar) does not brown to any extent. Thus, the role of caramelization in yeast-leavened products appears to be minor (Hoseney, 1994; Anonymous, 2008b.).

Whether the oven temperature is more or less than it should be has an effect on the enlargement of the dough and the oven temperatures should be adjusted in accordance with the type of product to be baked. When the temperature and cooking time are adjusted appropriately, it means that the inside of the baked product is fully cooked and the crust has taken on the desired color. Too early crust formation does not allow for sufficient expansion and volume, while too slow crust formation prevents the formation of a crunchy crust. The cut, which occurs by throwing a knife into the dough, causes the $CO_2$ gas to rise to the upper regions and to come out by opening channels for itself. If the knife throwing process has not taken place, splits or cracks occur on the surface of the dough. This process is especially important in large volumes of bread (Anonymous, 2008b).

Bread is baked at an average of 220-245 °C and in 18-20 minutes depending on the size. Modern ovens are produced according to the principle of exposure of the bread dough to be baked to different temperatures and steam within a certain period of time on trays, pans or moving belts. Bread ovens can be grouped into 5 main groups in terms of usage: rotary ovens, multi-story ovens, tunnel ovens, wood ovens and modular ovens. Breads that have just come out of the oven are subjected to cooling in cooling rooms or cooling belts. Cooling takes about 1 hour, depending on the ambient temperature. During cooling, excess water and alcohol formed as a result of fermentation are released (Anonymous, 2013). After baking, the bread should be removed from the pan to cool as quickly as possible. Leaving the bread to cool in the oven hardens the crust. If it is not removed from the pan, the bread does not breathe, sweats and softens during the cooling process (Kalkışım et al., 2012). If nonconformities are detected in the product coming out of the oven, a decision should be made according to the work instructions and quality requirements (Marques et al., 2012).

## 5. CONCLUSION

In order for the bread to reach the consumer in a safety and healthy way, first of all, it is necessary to know the errors and diseases of the bread and to take minimum measures to prevent these negativities in bread. There are many errors in the breads on the market caused by raw materials, production technology and lack of technical knowledge. All the negativities from the production stage of wheat to the storage, milling and bakery stage also have a share in this (Anonymous, 2012a).

The bread should be well risen when viewed from the outside. However, an exaggerated rise in bread due to space caused by improper application or unnecessary and inadequate use of additives is also undesirable. Apart from the fact that the bread is voluminous, its shape should be smooth and symmetrical, and there should be no bubbles and tears caused by gas pressure. The crust of the bread should be fried in color and homogeneous on all sides. The peel should not be thick (Anonymous, 2012a; Anonymous, 2012b). When the bread is cut with a transversely sharp knife, it should not stick to the knife or crumble. The inside of the bread should be as white-cream in color as possible, it should not show a striped, veined structure or gray areas in the bread. Apart from all these, one of the most important features sought in bread is that the bread has a unique taste and aroma, does not contain any foreign flavors or does not have an empty and bland taste (Anonymous, 2012a; Anonymous, 2012b).

One of the most significant advancements in bakery technology is the introduction of automated mixing and mixing systems. These systems combine precision engineering with computerized controls to produce consistent dough batches with minimal human intervention. By automating the mixing and mixing process, bakeries can save time and labor costs while achieving uniformity in product quality. Additionally, traditional ovens and proofing cabinets have been replaced by high-speed alternatives that offer faster baking and proofing times without compromising product quality. These cutting-edge ovens utilize innovative heating technologies, such as infrared radiation and high-velocity hot air circulation, to ensure rapid and even heat distribution. By reducing baking and proofing times, bakeries can increase their production capacity and meet the growing demand for bakery products (Anonymous, 2023).

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GIDA BİLİMLERİ VE MÜHENDİSLİĞİ KONULARI


yaz

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