FERMENTED – DRY SAUSAGE (SUCUK)



Dr. Hüseyin BOZKURT University of Gaziantep Sausages are usually defined as comminuted seasoned meats, stuffed into casings; they may be smoked, cured, fermented and heated.



INGREDIENTS

- MEAT: Meats used for sausages must be
 - fresh,
 - completed rigor-mortis phase
 - high quality,
 - with very low microbial counts,
 - good color,

Composition of Meat

•	Water	65-80 %
•	Protein	16-22 %
	 Myofibrillic protein (9.5 %) 	
	Actin	
	 Myosin 	
	 Sarcoplasmic protein (6.0 %) 	
	 Myoglobin 	
	 Hemoglobin 	
	 Stroma proteins (3.0 %) 	
	 Collogen, elastine 	
•	Fat	1.5- 13.0
	 Phospholipids, cholesterol 	
•	Carbohydrate	0.5-1.5 %
	 Glycogen and glucose 	

%

SALT (SODIUM CHLORIDE):

Salt provides

- flavors,
- essential in solubilizing muscle proteins,
- decrease the moisture,
- improve yield,
- influence textural characteristics.

NITRITE

Nitrite has several functions on meat products;

- 1. forms a bright red-pink color,
- 2. gains flavor and aroma,
- 3. prevents rancidity,
- 4. prevents growth of pathogenic microorganism,

ASCORBATE AND ERYTHORBATE

- These reductants react with nitrite to give nitric oxide, thus
 - fastening development of the pink-red color in cured sausages.
- Prevent formation of nitrosamines

SUGAR

- Sugar is added to meat as an adjunct
 - to counteract the salty taste,
 - to give flavor
 - to serve as a substrate for bacterial acid production in dry and semidry sausages.

SPICES

- Spices are aromatic vegetable substances in whole, broken or ground form.
- Spices may be added as natural spices or spices exracts.
- They are used to
 - give flavor (allspice, garlic)
 - give color (red pepper)

PHOSPHATES

- Phosphates are used to
 - give a phosphate source to microorganisms
 - increase the fermentation rate
 - buffering activity
- Some examples: sodium tripolyphosphate, tetrasodium pyrophosphate, sodium hexametaphosphate, sodium acid pyrophosphate, dissodium phosphate etc..

FERMENTED SAUSAGE TYPES

• 1. SEMIDRY SAUSAGES:

Semidry sausages differ greatly from dry sausages;

- By their high moisture content
- By their pronounced "tangy" flavor of forced fermentation resulting in lactic acid accumulation

2. DRY SAUSAGES

- The organoleptic and other properties of dry sausages depend upon;
 - The products of sugar bacterial fermentation
 - And strongly influenced by biochemical and physical changes occurring during the long drying or ripening process.

EXAMPLES OF FERMENTED SAUSAGES

- SUMMER SAUSAGES
- AIR-DRIED SAUSAGES
- PEPPERONI
- PORK AND BEEF CHORIZOS
- BEEF SALAMIS
- TURKISH AND ORIENTAL STYLE RAW BEEF SAUSAGES
- LANDJAEGERS

Sucuk

- Sucuk is a fermented dry meat product.
- Minced meat and fat are mixed with salt, sugar, spices, and little amount of other additional substances.
- These are filled into natural or artificial casing.
- Then, at specific temperature and moisture content they are ripened and dried.

Some Examples of Sucuk









Sucuk: DRY-FERMENTED SAUSAGE



PRODUCTION OF SUCUK

- Selection of raw materials
- Grinding, chopping and mixing
- Stuffing
- Ripening
 - Fermentation
 - Drying
- Storage

Selection of Meat

- The meat of adult and well fed animals is preferred.
- Dark-firm-dry (DFD) meat must not be used.
- High pH value of meats has high water holding capacity so causes some problems during ripening.
- Pale-soft-exudative (PSE) meat is not preferred for sausage manufacturing.
- The use of chilled meat with a low pH is most suitable.

Selection of Other Ingredients

• Tail fat should be frozen.

• Spices should have dry and free from microorganisms, toxin and etc.

• Spices should be fresh.



Grinding, chopping and mixing

- The extraction of protein while the spreading properties of the finished product will be improved.
- Meat is normally chopped first, and than other ingredients are added.
- Salt is added at the latest stage of chopping.









• Stuffing into casing should also be done firmly and carefully to exclude air.

• Air inside the casing will discolor meat and reduce self life.













• The drying rate should be as low as possible.

• The most critical point in drying is to avoid the formation of case-hardening.









Ripening (Fermentation and Drying)

- During the ripening;
 - pH reduced
 - Desired color formation (nitrosomyoglobin) observed
 - Nitrite level decreased
 - Desired flavor formed



- Biogenic amines could be formed
- Microorganism count decreased
- Desired texture attained



- If stored in a warm room, sucuks shrink excessively and become firm.
- If left in too humid or too cool room, they soon lose their color.
- Optimum storage conditions: 50-65 % relative humidity, and 18-22°C.





Factors Affecting Ripening and Storage of the Sucuk

Temperature 1. External Factors Air-condition

2. Internal Factors

Raw Material Salt and sugar 🖉 Water activity Initial Number of Starter Culture. pН

Microbial Activity in Ripening and Storage Periods

- Two basic microbial activities proceed during the fermentation period.
 - Reduction of pH by lactic acid bacteria,
 - Formation nitric oxide by nitrate and nitrite reductase activity of microorganisms

1. Lactic Acid Bacteria (LAB)

- LAB has a number of beneficial effects on the manufacturing process, quality and shelf-life.
 - inhibits undesirable microorganisms.
 - helps to develop texture
 - accelerates gelatinization.
 - controls enzymic activities that contribute to aroma.
 - favors color formation

2. Micrococcus and Staphylococcus

- Bacteria of Micrococacceae family,
 - Microflora or
 - Added as starter culture,

an essential role in the reduction of nitrate to nitrite by means of their nitrate reductase activity.

• The catalase of *Micrococacceae* which breaks down peroxides, including hydrogen peroxide produced by Lactobacilli and rancidity is inhibited.

- •Micrococacceae have an ability to break down
- fat (lipolysis) and
- protein (proteolysis)

which have great importance in the development of flavor, also stabilize the color in dry sausage

3. Molds and Yeasts

The surface flora of dry sausages, mainly the genus *Penicillum*,

•protects from harmful effects of air, and light,

•makes drying the sausages easier and

•gives them their typical aroma

Starter Cultures and Their Effects

•Lactobacillus, Micrococcus, Pediococcus, Staphylococcus, Debaryomyces, and Penicillium

•Mixed cultures of lactobacilli and micrococci have given much better results for

- •reducing ripening period,
- •development of flavor,
- •development of color,
- •development of texture
- •development of firmness and
- •prolonging the shelf-life.

• Debaryomyces hansenii

- for unique and more aromatic flavor
- better and homogeneous color development
- inhibit surface flora.

Species used as starters	Useful metabolic activity	Benefits to sucuk fermentation
L. plantarum, L.pentosus, L.sake, L. curvatus, P.pentosaceus, P. acidilactici	Formation of lactic acid and bacteriocins	Inhibition of pathogenic and spoilage bacteria Acceleration of color formation and drying
S. carnosus, S. xylosus M. varians	Nitrate reduction and oxygen consumption Peroxide destruction Lipolysis	Color formation and stabilization Removal excess nitrite Delay of rancidity Aroma formation
Debaryomyces hansenii	Oxygen consumption Lipolysis	Delay rancidity Aroma formation
Penicillium nalgiovense biotype 2, 3, 6	Oxygen consumption Peroxide destruction Lactate oxidation Peoteolysis Lipolysis	Color stability Delay of rancidity Aroma formation Aroma formation Aroma formation

Chemical Changes in Sucuks during the Ripening

- **1. Acid Formation (pH Reduction)**
- 2. Lipid Oxidation (2-Thiobarbituric Acid Formation)
- **3.** Color Formation (Nitrosomyoglobin Conversion)
- 4. Formation of Biogenic Amines

1. Acid Formation (pH Reduction)

- The rate and extent of acid formation must be adjusted carefully to achieve both
 - favorable sensory quality and
 - safety from pathogens.
- Acid formation rate depends on
- the activity of lactic acid bacteria,
- ripening temperature,
- ability of lactic acid bacteria to ferment sugars and
- the rate of drying.



2. Lipid Oxidation

- Lipid oxidation may have significant problems on the quality
 - color,
 - flavor,
 - texture and
 - nutritional value changed
- As a result of oxidation malonaldehyde is formed.
 - causes cancer and mutation.

3. Color (Nitrosomyoglobin) Formation

- The characteristic color (nitrosomyoglobin) of dryfermented sausage is produced by interaction between the meat pigments (myoglobin) and nitrite and nitrate.
- *Micrococcaceae* are responsible for the production of nitrosomyoglobin.



If iron molecule in the heme is oxidized to Fe⁺³, meat color is changed to brown-red color



4. Formation of Biogenic Amines

- Biogenic amines could be found in meat, sausages, milk, chocolate, cheese, fishes and some beverages.
- Biogenic amines are toxic substances; can cause nausea, respiratory distress, hot flushes, sweating, heart palpitation, bright red rash, oral burning, gastric, intestinal problems, and hyper— or hypotension.
- Histamine intake of 8-40 mg, 40-100 mg and higher than 100 mg, may cause slight, intermediate and intensive poisoning, respectively.

4. Formation of Biogenic Amines

- The allowable maximum level of tyramine in foods is 100-800 mg/kg and 1080 mg/kg of tyramine is toxic.
- Spermine, spermidine and cadaverine have not adverse health effect, but
 - they may react with nitrite to form carcinogenic nitrosamines and
 - also can be proposed as indicators of spoilage.

Major biogenic amine and precursors

Amine	Precursor	Pharmacological effects
Histamine	Histidine	Liberates adrenaline and noradrenaline Excites the smooth muscles of the uterus, the intestine and the respiratory tract Stimulates both sensory and motor neurons Controls gastric acid secretion
Tyramine	Tyrosine	Peripheral vasoconstriction Increases the cardiac output Causes lacrimation and salvation Increases blood sugar level Releases noradrenaline from the sympathetic nervous system Causes migraine
Putrescine and cadaverine	Ornithine and lysine	Hypotension Bradycardia Lockjaw Paresis of the extremities Potentiate the toxicity of other amines
β-Phenylethylamine	Phenylalanine	Releases noradrenaline from the sympathetic nervous system Increases the blood pressure Causes migraine
Tryptamine	Tryptophane	Increases the blood pressure

Formation of Histamine



Metabolic pathways of the some di- and polyamines



Formation of Nitrosamines

Presence of secondary and tertiary amines react with nitrogendioxide and nitrose acids to form nitrosamines



Nitrosamins are - cancerogenic

- mutagenic
- teratogenic



 $HONO + Dimethylamine \rightarrow Dimethyl nitrosamine + HOH$

Chemical Criteria	Limits
Moisture (mass)	max. 40 %
Salt (mass)	max. 5 %
Coloring matter	None
рН	min. 5.4 - max. 5.8
Fat (mass) for first quality for second quality for third quality	max. 30 % max. 40 % max. 50 %
Protein (mass) Nx6.25 for first quality for second quality for third quality	min. 22 % min. 20 % min. 20 %
Microbial Criteria	Limits
Total Aerobic Mesophilic bacteria (CFU/g)	10 ⁵ -10 ⁶ in 2 sample out of 5 sample
Escherichia coli (CFU/g)	None
Staphlococcus aureus (CFU/g)	0-100
Salmonella (CFU/g)	None in 25 g sample
Mold and yeast (CFU/g)	0-100
Clostridium perfingens (CFU/g)	10-100 in 2 sample out of 5
Coliform bacteria (CFU/g)	Maximum 10

Organoleptic Properties of Sausages

• Organoleptic characteristics of sausages could be divided into three groups; appearance, cooking and eating properties.

Appearance Properties

 Casings shouldn't have torn, it should have characteristic taste, odor and good appearance. Desired taste in sausage is lactic acid taste because sausage is fermented product.

Cooking Properties

 Under normal conditions of frying or grilling sausages should not loose more than 10 % of their weight as water or fat and a loss exceeding 20 % is not acceptable. As well as suffering only a limited weight loss, sausages should not shrink or distort excessively when cooked.

Factors Affecting Fermentation, Maturation and Storage of the Sausage



Quality of Turkish Style Sausage

- Physical criteria
- Chemical criteria
- Microbial criteria
- Organoleptic criteria

Defects

1. Appearance Defects

- shape deformation
- saltiness
- oil diffusion
- unstabilized color

2. Color Defects

- unsufficient and unstabilized color formation
- core color defects
- dark and rancid color formation.

3. Flavor and Taste Defects unsufficient color

- souring
- microbial
- bitter and rancidity



dark 🛶

good



