UNIT 10 TECHNOLOGY OF PASTA PRODUCTS

Structure
10.0 Objectives
10.1 Introduction
10.2 Durum Wheat and Its Quality
10.3 Durum Wheat Semolina Processing
10.4 Quality Characteristics of Semolina
10.5 Pasta Processing
10.6 Pasta Quality Evaluation
10.7 Let Us Sum Up
10.8 Key Words
10.9 Answers to Check Your Progress Exercise
10.10 Some Useful References

10.0 OBJECTIVES

After completion of this unit, you should be able to:
• know about durum wheat and semolina;
• become aware of the different types of pasta products;
• understand the quality of durum wheat and semolina;
• knowledgeable about the processing of pasta products; and
• know regarding the quality evaluation of pasta products

10.1 INTRODUCTION

Pasta products preparation and use dates back to many centuries. The Italians popularized them as “Pasta Alimentare” (Alimentary paste) since these products are made from alimentary dough of wheat semolina or flour and water. The popularity and wide spread consumption of these products is mostly due to their simple formulation, easy processing, shelf life and versatility of their use in various food preparations. The other reasons for increase in consumption of pasta products are convenience, economics, taste and nutrition. The pasta which is available in different shapes and sizes is versatile as it can be used as appetizer, main dish, side dish, soup or dessert.

Pasta products constitute of macaroni, spaghetti, vermicetti and noodles. Pasta products in India are designated as Macaroni products. According to prevention of food adulteration act, macaroni products means the products obtained from soji or maida with or without addition of ingredients like edible ground nut flour, tapioca flour, soya flour, milk powder, spices, vitamins and minerals while the Bureau of Indian Standards added casein, gluten and vegetables to the raw materials.
10.2 DURUM WHEAT

Botanically, wheats are classified into three groups according to their chromosome makeup. Diploid wheats are those with two sets of seven chromosomes (14 chromosomes), tetraploid wheats have four sets of seven-chromosome (28 chromosomes) and hexaploid wheats have six sets of seven chromosomes (42 chromosomes). Durum wheat is a tetraploid and is used for pasta production. The durum varieties account for only 4% of the total world wheat production. India is a major durum wheat producer.

10.2 Physico-chemical Characteristics of Durum Wheat

10.2.1 Test weight

Test weight is the bulk density of wheat, expressed as kilograms per hectoliter. Higher the test weight greater the percent of endosperm and in turn greater the yield of semolina. A minimum test weight of 82 kg/hl for durum wheat is generally specified by millers.

10.2.2 Thousand kernel weight

Refers to the weight of 1000 wheat kernels. Thousand kernel weight ranges from about 30 to 55g for sound, well-matured durum wheat. Higher the value, greater the potential of semolina yield.

10.2.3 Kernel vitreousness

Hard, vitreous kernels are almost synonymous with durum wheat. Kernel hardness is desirable for production of semolina. It is generally found that more semolina is produced from highly vitreous wheats than from less vitreous wheats.

10.2.4 Moisture content

Moisture content is one of the most important factors affecting durum quality. Ideally, wheat moisture should be between 10.5 and 12.5% for proper storage and handling. Levels higher than 14.0% often lead to microbial contamination, infestation and spoilage.

10.2.5 Protein content

Protein content is considered an important quality factor in all wheats. The average protein content of commercial durum wheat ranges from 10-18% and is higher than that of common wheat. Semolina with a protein content of 13% requires a wheat with a protein content of 14.0 to 14.5%.

10.3 DURUM WHEAT SEMOLINA PROCESSING

Because the durum kernel is very hard it yields high amounts of large particles (semolina) on grinding. The inherent hardness of wheat makes it necessary to grind durum more vigorously if the desired product is flour, instead of semolina. A commercial mill can be expected to obtain extractions of 60-64% semolina and 8-12% flour.

The mechanics of milling durum wheat differ from those of milling wheat into flour. Grinding with corrugated rolls to maintain granularity can be accomplished by grinding with break or corrugated rolls. Small bran particles are removed from the semolina using purifiers, which separate particles based on size and density. Good purification is required since bran or other dark particles are readily visible in the yellow semolina. Prior to milling durum wheat must be tempered to moisture content.
of about 16.0-16.5%. The tempering is usually done in two or three stages, tempering time is short, 4 hour or less. The tempering time is kept short because it is necessary only to “toughen” the bran, and not to mellow the endosperm. A mellow endosperm favours flour production, which is not desirable in durum milling. A final water addition of as much as 2% may be provided as little as 20 minutes before milling, and this has the desired effect of toughening the bran as required to produce clean semolina with a minimum of bran specks. The final stage of tempering is designed to toughen the bran so that it does not shatter excessively, as this would make it more difficult to separate the bran from the endosperm in the purifier.

Sound durum wheat is very hard and vitreous in nature, and is therefore readily reduced to the granular product, semolina, with minimum production of flour. Semolina is used in the production of pasta products the world over as durum wheat contains relatively large amounts of yellow pigment. Semolina is clear, bright and golden in colour. This desirable appearance is not significantly diminished by the presence of small quantities of brown bran specks. However, dark specks originating from impurities in the wheat adversely affect the appearance of semolina and the bright colour of the finished pasta product.

Effective milling of durum wheat into semolina involves careful selection of high-quality grain, cleaning and skill in milling. Durum milling requires extensive cleaning to ensure that only uniform and unblemished wheat proceeds to mill.

In the mill, durum milling differs markedly from hard or soft wheat milling at every stage. Durum milling contains about 5-6 break passages. The extra break passages enable the miller to grind more gently and gradually at each stage, thereby facilitating the release of endosperm in particles as large as possible to ensure maximum production of semolina. The profile of corrugations used in the durum mill is generally sharp, to minimize the amount of fine material produced during the breaks and sizings of semolina. Corrugations are usually set “sharp to sharp”, which means that the sharpest angle cuts into the wheat kernel to produce larger chunks of endosperm with a minimum amount of fines.

After the break rolls, the purified coarse semolina is sent to corrugated sizing rolls, instead of smooth reduction rolls. The object is to gradually reduce the coarse semolina. The “sized” semolina is then again graded and purified. The major portion of the finished product, semolina, emerges from the second purification. A durum mill has a large number of purifiers present.

10.4 QUALITY CHARACTERISTICS OF SEMOLINA

Durum wheat is most suitable for pasta products as it is the hardest of all wheats. Because the durum kernel is very hard, it yields high amount of semolina on milling (60-64%). The particle size range of semolina preferred is 150-350 μ. Semolina particles below 350 μ in diameter are easier to process and yield more homogenous and translucent pasta. The durum gives pasta with superior cooking quality compared to non-durum wheat. Hence, yellow pasta is considered superior and durum wheat contains more carotenoid pigments responsible for yellow colour. Brown specks which are contamination of bran and black specks as well as grit which come from extraneous matter are not desirable in semolina as they affect the quality of pasta. The ash content of semolina of 65% extraction which ranges from 0.55 to 0.75% reflects the quality of semolina. The protein content desired is 11.5 to 13% for satisfactory results in pasta manufacture. Gluten from durum semolina should have a bright yellow colour and should be free from shades of brown or grey. Both damaged
starch and alpha amylase activity should not be higher as they cause increased loss of solids into the cooking water.

10.4.1 Moisture

The moisture content is an important factor in processing pasta. Semolina moisture should be as high as possible without risking the hazards of spoilage or deterioration during storage and the stickiness and poor flow properties associated with excessive moisture. An acceptable level is 13.5-14.5%.

10.4.2 Granulation

Granulation or particle size distribution of semolina is important since it has an effect on the absorption properties of the pasta dough and therefore influences the quality of the finished pasta. Since coarse particles hydrate at a different rate than fine particles, it is undesirable to have too wide a range in particle size. Fine semolina hydrate more rapidly than coarse particles. These unhydrated particles produce inferior, unattractive pasta with white specks. Semolina below 350 μm in diameter is easier to process into a more homogenous and translucent pasta than coarse semolina. However, particles of semolina that are relatively small are high in damaged starch, which increases the loss of solids into cooking water during pasta cooking.

10.4.3 Semolina Colour

Colour of the semolina is influenced by its particles size, enzyme content, and processing conditions. Finer the semolina, whiter the colour for appearance. This is due to the amount of light reflected from the surface of the particles. Secondly, the colour to semolina is imparted by the carotenoid pigments xanthophylls and lutein. Presence of lipoxygenase can reduce the amount of yellow pigments as the semolina is processed into pasta. Although lipoxygenase is concentrated in the germ and bran portions of the durum kernel, cultivars with inherently high concentrations have higher levels of the enzyme in the semolina. All semolina or flours contain some lipoxygenase which bleaches a portion of the yellow pigment during the processing of dough into macaroni.

10.4.4 Semolina Lipoxygenase Activity

The level of lipoxygenase activity in semolina varies with the variety of wheat being milled and with the extraction rate. Semolina normally have 8 to 40 units of lipoxygenase. Within this range, the normal processing, pigment loss during processing will vary from 15 to 60%. High-grade semolina milled from high quality durum will normally have a lipoxygenase activity in the range of 10 to 20 units.

10.4.5 Speck Count

Specks in semolina are caused by any material with a colour that contrasts with the durum endosperm particles that make up the semolina. Speck concentration is usually determined by counting the number of brown or black pieces. Wheat bran is the most common source of brown specks. Black specks are caused by materials such as discoloured wheat kernels, weed seeds, ergot or dirt.

10.4.6 Grit Content

Grit is any hard object (e.g. Metal, stone or glass) in the semolina that can stick in the pasta extrusion die and cause streaking or tearing of the dough as it passes by. The gritty material might also be extruded and become part of the pasta which is hazardous to the consumer. The grit can be detected in the laboratory by floating semolina in carbon tetra chloride in a separatory funnel. The grit particle being heavier than semolina settles to the bottom of the liquid.
10.4.7 Ash Content

The ash content in the endosperm of durum is higher than in the endosperm of other hard wheats. The percent of ash in durum semolina or flour can be used as a relative measure of bran. The ash content in commercial durum semolina of about 65% extraction normally ranges from 0.55 to 0.75%.

10.4.8 Protein Content

The protein content of semolina is important because it influences the functional quality of pasta. Adequate amounts of gluten proteins are necessary to impart the desirable attributes of mechanical strength and cooking quality to pasta. Semolina with protein levels of 11.5 to 13.0% process with little difficulty and can be expected to give satisfactory results. Too low a protein is likely to produce pasta with relatively poor mechanical strength in the dried product and less than optimum quality with respect to cooking stability and cooked firmness. On the other hand, protein levels that are too high may result in products that stretch excessively up to extrusion.

10.5 PASTA PROCESSING

Pasta is the most commonly consumed product made from durum wheat.

Pasta or alimentary pasta come in a variety of shapes and sizes. The pasta manufacturer generally refers to these products as either long goods or short goods. Long goods include spaghetti and vermicelli. Short goods include such shapes as macaroni, noodle, elbows, stars and many other fancy shapes. Regardless of long or short goods classification, all pasta products are fashioned from dough made by mixing water with wheat semolina (or flour) and usually from durum wheat.

10.5.1 Macaroni

There are two types of macaroni known as long and cut goods. The long goods are smooth or corrugated tubular rods. Having outer diameter ranging between 3 and 5 mm and wall thickness of about 1 mm. The length is in the range between 250 and 275 mm. The cut goods are in the form of elbows, tubes, shells, alphabets, numerals, stars, wheels, rings, rice, melons seeds etc.

10.5.2 Spaghetti

It is in the form of solid rods having diameter of 1 mm and length ranging from 250 and 275 mm.

10.5.3 Vermicelli

It is in the form of solid rods having diameter between 0.5 and 1.2 mm and length ranging from 25 to 250 mm.

10.5.4 Noodles

These are flat strips having the thickness of 1 to 2 mm and varying in length. They invariably contain 5% egg which impart colour and flavour to the product.

Process

The semolina and water are metered into the mixing chamber in a predetermined ratio. The metering rate depends on the output of press and dryer capacity. The typical capacities are in the range of 200-1200 kg/hr. Some mixing chambers operate under vacuum as it minimizes pigment oxidation and removes trapped air bubbles. In the extrusion chamber the hydrated semolina is transformed into a cohesive plastic mess. During extrusion, as heat generation is considerable, the chamber is cooled.
by cold water circulation to maintain 50°C temperature. Pasta of various shapes and sizes are made with change of dies and cutters. Over 600 pasta shapes are known to exist. Drying is the most critical phase in processing. Moisture should be removed at a uniform rate to prevent moisture gradients with in the strands that can cause checking or cracking. The product is subjected to a blast of air for surface drying called case hardening. The surface drying sets the shape and prevents stretching. In the predryer the moisture is reduced from 30% to about 20% in about 1 hr with temperature at 6.5°C and relative humidity of 65%. The main dryer is controlled at 55°C with RH initially at 95% and decreasing to 70%. The final stage is conditioning, where the moisture of 12% is achieved and the product is cured. The total time varies from 15 to 28 hr. presently, combination of conventional and high temperature drying (over 70°C) are being used by many manufacturers of pasta which has reduced the total drying time and improved the cooling quality of pasta.

The final step in pasta production is packaging. Basically, the major considerations are sufficiently gentle mechanical handling to ensure minimal product breakage and high degree of accuracy and precision in the weighing and filling of the packages.

10.6 QUALITY EVALUATION OF PASTA PRODUCTS

10.6.1 Appearance

Appearance of pasta is influenced by its size and shape, colour, uniformity, clarity and surface texture. Desirable attributes of pasta are translucent, bright yellow, free from excessive specks, cracks or checks and smooth surface.

10.6.2 Mechanical Strength

Mechanical strength of dry pasta is important as the product has to withstand the rigours of cutting, packing, handling and transport. The pasta mechanical strength is measured subjectively by squeezing or bending by hand or objectively using Instron Universal Testing Instrument.

10.6.3 Cooking Quality

The pasta should have pleasing flavour and mouthfeel, should retain yellow colour, should not release excess solids into the cooking water, should not be sticky when eaten and should exhibit some firmness to bite.

1. The standards for pasta products in India

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<thead>
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<th>Characteristic</th>
<th>Requirement</th>
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<tr>
<td></td>
<td>PFA</td>
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<tr>
<td>Moisture (%)</td>
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<td>Total ash (%) dry basis</td>
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<td>Acid insoluble ash (%) dry basis</td>
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<tr>
<td>Total protein (NX5.7) dry basis</td>
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<tr>
<td>Nitrogen (%) dry basis</td>
<td>1.7</td>
</tr>
<tr>
<td>Total solids (%) dry basis</td>
<td>-</td>
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Cooking test for pasta products

Bring to boil 250 ml of water in a beaker.

Add 25 g of pasta product (10 mm lengths for long goods)

Cook in pasta for 10 min in boiling water. Drain the cooked pasta for 5 min using a strainer. Measure the volume of gruel collected. Pipette out 20 ml of gruel into a petridish, dry on water bath and then in air oven at 105 ± 2°C till constant weight to find out the total solids in gruel.

Total solids in gruel % by mass = \( \frac{(M_2-M_1)}{V} \times \frac{100}{20} = \frac{(M_2-M_1)}{5} \)

where \( V \) = Volume of gruel

\( M_2 \) = Weight of petridish with gruel before drying

\( M_1 \) = Weight of petridish with solids after drying

Check Your Progress Exercise

Note: a) Use the spaces given below for your answers.

b) Check your answers with those given at the end of the unit.

1. What is meant by durum wheat?

2. How is durum wheat processed into semolina?

3. Define the various pasta products

4. Describe the semolina quality parameters
5. How is pasta processed?

6. Detail the drying process of pasta.

7. What quality checks are conducted on pasta products?

10.7 LET US SUM UP

Pasta products constitute of macaroni, spaghetti, vermicelli and noodles. Durum wheat semolina or flour is most constitute for past products. Durum wheat a tetraploid is an extra hard wheat with high protein content and carotenoid pigment content. The extra hardness gives high semolina yield, high protein is suitable for extrusion and yellow pigment gives pleasing colour to the pasta. The test weight, thousand kernel weight, moisture content and protein content are important parameters for quality evaluation of durum wheat. The milling of durum wheat into semolina is based on cleaning, short time tempering, grinding in break rolls, reduction in sizing rolls and purification in purifiers. The extraction of durum semolina is about 60-64% with particles in the range of 150-350μ. Moisture, granulation, colour, lipoxygenase activity, speck count, grit count, ash and protein are important quality characteristics of semolina. The pasta is produced by mixing semolina and water, extruding it through a press. The pasta of various shapes and sizes are made with change of dies and cutters. Drying is a critical operation which involves reduction in moisture from 30 to 12% using varied relative humidity and temperature over a period of 15 to 28 hr. The quality of pasta is tested by evaluating appearance, mechanical strength and cooking quality. The cooked pasta should have pleasing flavour, good mouth feel, yellow colour, non-stickiness when eaten and firmness of bite.

10.8 KEY WORDS

Durum wheat: It is a tetraploid wheat having 28 chromosomes. Extra hard, high protein, vitreous wheat with high yellow pigment content. Suited for semolina milling and making pasta products.

Pasta products: Products made from dough of wheat semolina or flour and water by extrusion and drying.
Macaroni: Macaroni products are long and cut goods. The long good are smooth or corrugated tubular rods while the cut good are alphabets, numerals, stars, elbows, shells, tubes etc.

Spaghetti: It is in the form of solid rods of 1 mm diameter and 250 mm length.

Vermicelli: It is in form of solid rods of 0.5 to 1.2 mm diameter and less than 250 mm length.

Noodles: Noodles are flat strips of 1 to 2 mm thickness.

Semolina quality: Moisture, granulation, colour, lipoxidase activity, speck count, grit content, ash and protein form the parameters for quality evaluation of semolina.

Pasta processing: Semolina or flour and water make into a dough and extruded to get desired product using a suitable die.

Pasta drying: The drying of extruded pasta using controlled temperature an humidity to bring down the moisture to less than 12% is known as pasta drying.

Pasta quality evaluation: Appearance, mechanical strength, and cooking quality are the parameters for quality evaluation of pasta products.

10.9 ANSWERS TO CHECK YOUR PROGRESS

EXERCISE

1. Durum wheat is tetraploid having 28 chromosomes. It is extrahold, vitreous and high protein wheat and rich in yellow carotenoid pigement. It yields high extraction of semolina on milling and is best suited for making pasta products.

2. Durum wheat processing involves cleaning of wheat and conditioning with addition of water and resting. It is the processed in the mill containing 5-6 break rolls to get maximum yield of semolina. The semolina is sized, graded and purified. The semolina thus obtained is used for making pasta products.

3. The pasta products are macaroni, spaghatti, vermicelli and noodles. The macaroni products are long and cut goods consisting of tubular rods, alphabets, numerals, stars, elbows, shells, etc. The spaghatti is solid rods thicker in nature and vermicelli is solid rods thinner in nature. The noodles are flat strips. All these products are made from wheat semolina or flour and water by mixing, extrusion or sheeting and cutting and drying.

4. The semolina quality parameters are moisture content, granulation, colour, lipoxidase activity, speck count, grit content, ash content and protein content.

5. Wheat semolina or flour and warm water are mixed in mixer. The addition of water is adjusted to obtain a dough of 30% moisture. The dough is passed through vacuum chamber and then through extrusion chamber. The extruder is cooled with circulation of water to keep the dough temperature at 50°C. The dough is forced through a die and cutting arrangement to obtain pasta products of desired shape and size. The pasta is then dried.
6. The pasta after extrusion is dried using controlled temperature and humidity. This facilitates slow and proper migration of moisture from inner to the outer surface. Excessive moisture gradient in the product results in cracking. The pasta is dried in pre drier at 65°C and 65% RH. In the final drier the humidity decreases from 95 to 70% and total time for drying is 15-22 hrs to remove moisture from 30% to less than 12% in the final product.

7. The parameters for evaluation of pasta products are appearance, mechanical strength and cooking quality. The pasta should be translucent, bright yellow, free from specks and should have smooth surface. The mechanical strength is measured by subjective or objective method. The percentage solids leached during cooking are estimated and it should be less than 8%.

10.10 SOME USEFUL REFERENCES

1. Alsberg C. L. 1939. Durum wheats and their utilization - wheat studies Food Research Institute, USA


5. Pomeranz. Y. Wheat chemistry and technology – American Association of cereal chemists, minneapolis, USA