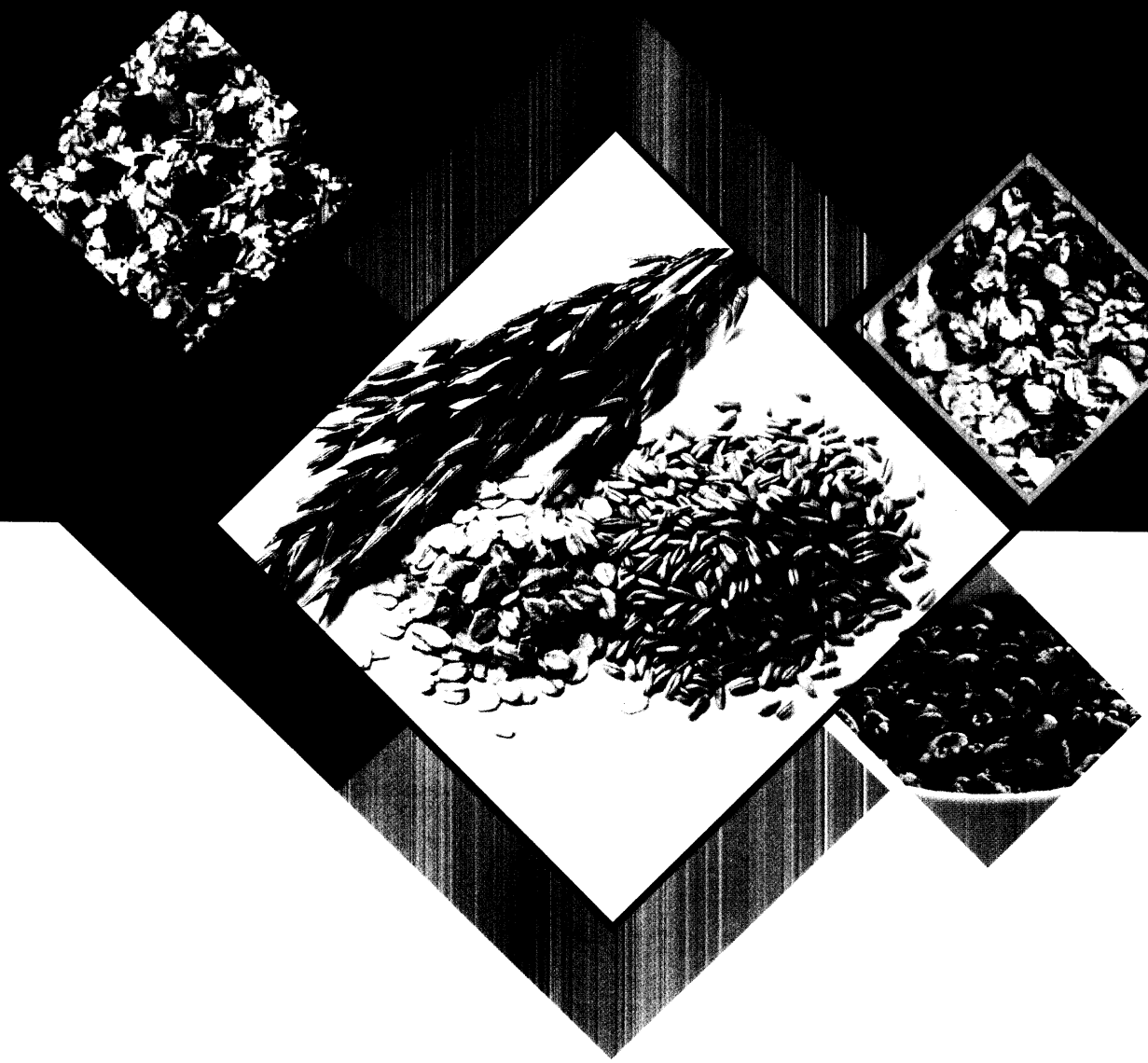
PRACTICAL MANUAL

Cereal Processing

B. Tech (Food Technology)

Course No.: FPT-123

Course Credit: 3 (2+1)



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Certificate

This is to certify that Mr/Ms. _____

Studying in B.Tech (Food Tech) II[nd] semester has performed set of experiments of the subject (Cereal Processing) with course number FPT-123 satisfying in the year 20 - 20

Date:

Head of Dept. of FPT

Course Teacher

INDEX

EXPERIMENT NO. 1

Determination of physical properties of cereal grains

Objective: To determine the physical properties of cereal grains

Relevant Information: Data on physical properties of grain is essential for the design of equipment for handling, aeration, and storage, as well as processing cereal grains. The most important such properties are the grain dimensions or size, 1000 kernel weight, Percent dockage, color, hardness, kernel density, bulk density, fractional porosity, angle of repose and Degree of sphericity.

Materials required: cereal grains, Vernier-caliper, weighing balance, photographic enlarger measuring cylinder

Procedure:

A. Grain size: It is also a factor related to quality of product. It also gives the indication of varietals purity. Classification of rice / paddy is generally carried out based on length / width ratio.

Procedure

1) Count twenty cereal grains from the sample randomly.
2) The length, width is measured by a Vernier-caliper or photographic enlarger to of each of the twenty grains and expressed as A and B.
3) The length-width ratio can be calculated by using the following equation:

$$\text{Length to width ratio } (L/W) \quad \frac{\text{Average paddy length}[A]}{\text{Average paddy width}[B]}$$

Observations:

1. Name of the sample:_____
2. Length of paddy grain(L):_____
3. Width of paddy grain(W):_____
4. L/W ratio:_____

A. 1000 kernel weight: In handling and processing of grains, it is customary to know the weight of 1000 kernels. The 1000 kernel weight is a good indicator of the grain size, which can vary relative to growing conditions and maturity, even for the same variety of a given crop. When compared with other crops at the same moisture level, the 1000 kernel weight will also provide an idea of relative size of the kernel for handling purposes.

Procedure

1) From the sample of paddy grain supply, count 1000 whole grains randomly
2) Take accurate weight of these grains on a precise balance.

Observations:

1. Name of the sample:_____
2. Weight of 1000 kernel (g):_____

B. Percent dockage:

Dockage includes chaff, stones, weed seeds, soil, rice straw, stalks and other foreign matter. These impurities generally come from the field or from the drying floor as in developing countries paddy & other cereals are harvested by traditional method. Technically impurities are called as dockage. Separate the chaff, stones, weed seeds, soil, rice straw, stalks and other foreign matter, then weigh it and calculate their percentage which is inversely proportional to the grain quality.

Procedure

1. Weigh the sample **[A]**
2. Weigh all the foreign matter, stones and weed seeds removed **[B]**
3. Calculate the Percent dockage

$$\%\ Dockage \quad \frac{Wt\ of\ dockage[B]}{Total\ wt\ of\ sample[A]}\ x\ 100$$

Observations:

1. Name of the sample:_____
2. Weight of dockage:_____
3. %dockage:_____

C. Colour:

1) Colour is most appealing factor for any consumer to decide the quality of product. It may differ from variety to variety.
2) The colour of grain is measured by Munshell colour chart. In colorimetry, the Munsell color system is a color space that specifies colors based on three color dimensions: hue, value (lightness), and chroma (color purity).
3) The system consists of three independent dimensions which can be represented cylindrically in three dimensions as an irregular color solid: hue, measured by degrees around horizontal circles; chroma, measured radially outward from the neutral (gray) vertical axis; and value, measured vertically from 0 (black) to 10 (white).
4) While using colour chart, the grain samples are compared with the colours on chart. The color of the grains is then expressed in the values of Hue, Value and Chroma. A colours is fully specified by listing the three numbers for hue, value, and chroma in that order.

Observations:

1. Name of the sample: _____
2. Color of the grain:_____

D. Hardness:

1) Hardness of grain is related to quality of product with respect to shelf life.
2) It is factor which is related with the moisture and protein content of grains.
3) If the moisture content of grain is less – the grain will be harder and vice versa
4) If the protein content of grain is less – the grain will softer and vice versa.
5) Traditionally the hardness is checked by breaking the grain by teeth.
6) In laboratory hardness is determined by hardness tester.
7) Grain is placed in tester & pressure is applied on the grain with the help of screw & pressure is noted down in Kg / cm^2 at which the cracking noise is heard.

Observations:

1. Name of the sample:_____
2. Hardness of the grain:_____

E. Kernel Density: The kernel (true) density of a grain is defined as the ratio of the mass of a grain sample to the solid volume occupied by the sample. For the determination of kernel density of an average grain, two methods have been suggested: one involved the displacement of a gas, whereas the other used displacement of a liquid. In both methods, Archimedes' principle of fluid displacement is used to determine the volume. Density of grain is related with its packaging and storage properties. It is the ratio of mass & volume of the product.

Procedure:

1) Weigh 20 gram of grain sample
2) Take 100 ml capacity measuring cylinder.
3) Add solvent like Kerosene / Toluene of known volume e.g. 50ml
4) Add previously weighted grain sample to the solvent.
5) Note down the increase in volume.
6) Calculate the Density as follows

Density = Wt. of sample grain / Increase in volume (g /ml)

Observations:

1. Name of the sample:_____
2. Increase in volume:_____
3. density of grains: _____

F. Bulk Density: The bulk density of cereal grains is determined by measuring the weight of a grain sample of known volume. The grain sample is placed in a container of regular shape, and the excess on the top of the container is removed by sliding a string or stick along the top edge of the container. After the excess is removed completely the weight of the grain sample is measured. The bulk density of the grain sample is obtained simply by dividing the weight of the sample by the volume of the container. The bulk density gives a good idea of the storage space required for a known quantity of particular grain.

Procedure:

1) Take 100 ml capacity dry measuring cylinder.
2) Fill the measuring cylinder till 100 ml mark with the grain.
3) Take out the grain and weigh it.
4) Calculate the Bulk Density as follows,

Bulk Density = Wt. of grain / 100 ml

Observations:

1. Name of the sample:_____
2. Bulk density of grains:_____

G. Fractional porosity: The porosity of grain is an important parameter that affects the kernel hardness, breakage susceptibility, milling, drying rate, and resistance to fungal development. Porosity is a property of grain that depends on its bulk and kernel densities. The grain porosity can be measured with the help of an air compression pycnometer or by the mercury displacement method. Fractional porosity is defined as that fraction of the space in the bulk grain that is not occupied by the grain. It is the

factor which is related to packaging & storage of product. More is the porosity more space for packaging and storage is required. The percentage fractional porosity can be calculated from the following relation:

$$\% \text{ Porosity} = \frac{\text{Density} - \text{Bulk Density}}{\text{Density}} * 100$$

Observations:

1. Name of the sample:_____
2. Density of grains:_____
3. Bulk density of grains:_____
4. % porosity:_____

H. Angle of Repose: Angle of repose is related with frictional properties of grain. It has effect on transportation, processing & conveying. Angle between the horizontal surface &slope of hip of the grain is called angle of repose. More the roughness of grain, more will be the coefficient of friction so more will be angle of repose. Angle of repose helps to determine the angle of hopper to control the flow of grains through hopper.

1) To measure the angle of repose, prepare a hip of grains in a petri-dish & measure the radius & height of hip.

Calculate the angle of repose as follows,

Angle of repose = $\tan^{-1}$(height / radius)

Observations:

1. Name of the sample:_____
2. Radius of hip:_____
3. Height of hip:_____
4. Angle of repose:_____

I. Degree of Sphericity: The shape of the rice was found to be cylindrical with three perpendicular dimensions, length (L), width (W) and thickness (T). The physical dimensions were determined randomly measuring the length, width and thickness of kernels using vernier caliper. The criteria used to describe the shape of the seed is the sphericity and aspect ratio. Thus, the sphericity (Sp) was accordingly computed as:

$$S_p = \frac{(LWT)^{1/3}}{L} * 100$$

Where L is the grain length, W the grain width and T is the grain thickness.

Observations:

1. Name of the sample:_____
2. Length of the grain:_____
3. Width of grains: _____
4. Thickness of grains:_____
5. Sphericity,:_____

Result:

EXPERIMENT NO. 2

Determination of moisture content of cereal grains

Objective: To determine the moisture content of cereal grains

Relevant Information: Cereal grains and their derivatives are an important nutritive component both in developed and in developing countries. Chemical and nutritional components of cereals are of key importance for selection of cereal grains in production of functional foods. Moisture is an important factor in food quality, preservation, and resistance to deterioration. Determination of moisture content also is necessary to calculate the content of other food constituents on a uniform basis (i.e., dry weight basis). The dry matter that remains after moisture analysis is commonly referred to as total solids. The moisture content of cereal grains is 11–14%. Moisture content has a significant influence on all aspects of quality. Moisture content has a significant influence on storage & shelf life of grains. Grain are at its optimum storage condition, when its moisture content is 14%.The oven drying method takes longer to perform but provides the most reliable measure of moisture content.

Principle:

The sample is heated under specified conditions and the loss of weight is used to calculate the moisture content of the sample.

Materials required: Aluminium dish, sample, weighing balance, electric oven etc.

Apparatus :

(a) Grinding Mill
(b) Moisture dishes
(c) Electric oven
(d) Desiccators containing an effective desiccant.

Procedure:

1. Mix the test sample and grind suitable quantity to give sufficient ground material for replicate determination. Ensure that the sample is neither too coarse nor too fine and passes through 1.0 mm sieve.

2. Weigh accurately about 5 gram of sample in a previously dried dish and place the dish with its lid underneath in the oven for 2 hours.
3. The time should be reckoned from the moment the oven attains 105°C after the dishes have been placed.
4. Remove the dish after 2 hours, cool in the desiccators and weigh. The dish should be placed back in the oven at half hour intervals till constant weight is achieved.
5. Compute the moisture content for each sample using the equation:

$$MC = \frac{Initial\ Weight - Final\ Weight}{Initial\ Weight} \times 100\%$$

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. Final Weight of the sample after drying:_____
4. % moisture content:_____

Result:

Determination of fat content of cereal grains by Solvent Extraction Method

Objective: To determine the fat content of cereal grains by Solvent Extraction Method

Relevant Information:

The lipid content of a food determined by extraction with one solvent may be quite different from the lipid content as determined with another solvent of different polarity. Fat content is determined often by solvent extraction methods (e.g., Soxhlet, Goldfish, Mojonnier), but it also can be determined by non-solvent wet extraction methods (e.g., Babcock, Gerber), and by instrumental methods that rely on the physical and chemical properties of lipids (e.g., infrared, density, X-ray absorption).

Pre-drying makes the sample easier to grind for better extraction, breaks fat-water emulsions to make fat dissolve easily in the organic solvent, and helps free fat from the tissues of foods. For Semi continuous solvent extraction, the solvent builds up in the extraction chamber for 5 to 10 minutes and completely surrounds the sample, then siphons back to the boiling flask. This method provides a soaking effect of sample and does not cause channeling. If the sample contains more than 10 percent moisture, dry the sample to constant weight.

Principle:

Fat is extracted, semi-continuously, with an organic solvent by the principle of " Like dissolves like". Solvent is heated and volatilized, then condensed above the sample. Solvent drips onto the sample and soaks it to extract the fat. At 15–20 min intervals, the solvent is siphoned to the heating flask, to start the process again. Fat content is measured by weight loss of sample or weight of fat removed.

Materials required:

Chemicals: Petroleum ether or Ethyl ether

Supplies: Aluminum weighing pans, Beaker, 250 ml ,Cellulose extraction thimbles, Desiccators ,Glass boiling beads, Glass wool , Graduated cylinder, Mortar and pestle ,Plastic gloves , Spatula, Tape (to label beaker) ,Tongs, Weighing pan

Equipment: Analytical balance, Soxhlet extractor, with glassware, Vacuum oven

Procedure

1. Slightly grind ~30 g sample with mortar and pestle or grinding mill.

2. Wearing plastic gloves, remove three pre-dried cellulose extraction thimbles from the desiccators.
3. Label the thimbles on the outside and then weigh accurately on an analytical balance. Place ~2–3 g of sample in the thimble.
4. Assemble boiling flask, Soxhlet flask, and condenser.
5. Weigh pre-dried boiling flask. Put ~350 ml petroleum ether in the flask, add several glass boiling beads, and extract for 6 hr or longer.
6. Extract in a Soxhlet extractor at a rate of 5 or 6 drops per second condensation for about 4 hrs, or for about 16 hrs at a rate of 2 to 3 drops per second by heating solvent in boiling flask.
7. Dry boiling flask with extracted fat in an air oven at 100°C for 30 min, cool in desiccators, and weigh.
8. Remove thimbles from the Soxhlet extract or using tongs, air dry overnight in a hood, then dry in a vacuum oven at 70°Cfor 24 h. Cool dried samples in a desiccators then reweigh.
9. Correct for moisture content of product as follows:

(a) Using the remainder of the ground sample prepare for moisture analysis.

(b) Dry sample at 70°C, for 24 hr in a vacuum oven. Reweigh after drying, and calculate moisture content of the sample.

Calculation

% fat on dry weight basis

Crude Fat content = (g fat in sample/ g dried sample) x 100

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. Final Weight of the sample: _____
4. Initial Weight of the flask: _____
5. Final weight of the flask_____
6. % fat content: _____

Result:

EXPERIMENT NO. 4

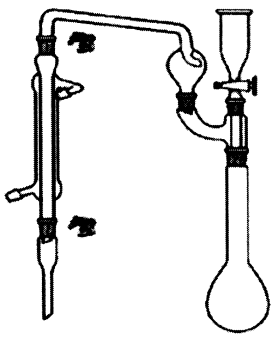
Determination of protein content of cereal grains by Micro-Kjeldahl Method

Objective: To determine the protein content of cereal grains by Micro-Kjeldahl Method

Principle The protein content is determined on the basis of the organic Nitrogen content by Kjeldahl method. The various nitrogenous compounds are converted into ammonium sulphate by boiling with concentrated sulphuric acid. The ammonium sulphate formed is decomposed with an alkali (NaOH) and the ammonia liberated is absorbed in excess of standard solution of acid and then back titrated with standard alkali.

Apparatus

a. Kjeldahl digestion flask
b. Kjeldahl distillation apparatus, - same digestion flask fitted with rubber stopper through which passes lower end of efficient rubber bulb or trap to prevent mechanical carryover of NaOH during distillation or apparatus as shown below.
c. Conical flask, 250 ml
d. Burette 50 ml.



Distillation apparatus

Reagents

a. Concentrated Sulphuric acid - sp gr 1.84
b. Sodium Hydroxide solution - 45%.
c. Standard Sulphuric acid solution – 0.1 N
d. Methyl Red Indicator solution - Dissolve 0.5 gm methyl red in 100 ml of alcohol

Procedure:

1. Weigh quickly about 1-2 g of the sample and transfer to a 500 or 800 ml Kjeldahl flask taking care to see that no portion of the sample clings to the neck of the flask.
2. Add 0.7 gm. of Mercuric oxide, 15 gm. of Potassium Sulphate and 40 ml of concentrated sulphuric acid.
3. Add two to three glass beads. Place the flask in an inclined position on the stand in the digestion chamber and digest. Heat the flask gently at low flame until the initial frothing ceases and the mixture boils steadily at a moderate rate. During heating rotate the flask several times.
4. Continue heating for about an hour or more until the colour of the digest is pale blue. If Black specs are present after 30 min of digestion, wrap the vessel with aluminium foil and keep for 2-3 min. By doing this black specs would move down from the walls in the digestion mixture. If the specs are still present, remove the vessel from heat and allow cooling for 10 mins. Do not modify the heat intensity in the whole process.
5. Cool the digest and add slowly 200 ml of water. Cool, add a piece of granulated Zinc or anti bump granules and carefully pour down the side of the flask sufficient Sodium Hydroxide solution (450gm/ litre) to make the contents strongly alkaline (about 110 ml) before mixing the acid and alkaline layer.
6. Connect the flask to a distillation apparatus incorporating an efficient flash head and condenser.
7. To the condenser fit a delivery tube which dips just below the surface of the pipetted volume of standard acid contained in a conical flask receiver.
8. Mix the contents of the digestion flask and boil until 150 ml have distilled into the receiver.
9. Add 5 drops of methyl red indicator and titrate with 0.1 N H_2SO_4 solutions.
10. Carry out a blank titration simultaneously.

1 ml of 0 .1 N H_2SO_4 = 0.0014gm N.

Observations:

1. Weight of sample: _____
2. Volume of digest made: _____
3. Volume of digest made for distillation: _____
4. Volume of std. H_2SO_4 required for titration (sample): ---------- ml.
5. Volume of std. H_2SO_4 required (blank): ---------- ml.
6. Normality of H_2SO_4 : --------- N.

Calculations:

$$N\% = \frac{(\text{Sample} - \text{blank}) \times N \text{ of } H_2SO_4 \times 0.014 \times 25}{\text{Aliquot taken} \times \text{wt. Of sample (g) for distillation}} \times 100$$

Most protein contains 16 % nitrogen, when N % is Multiplies by 100/16 = 6.25, the percent protein is obtained.

Protein % = % N X 6.25

Result:

EXPERIMENT NO. 5

Determination of Crude fiber content of cereal grains

Objective: To determine the Crude fiber content of cereal grains

Materials required: reflux condenser, boiling flask, sample, glass beads, Gooch crucible

Reagents:

(a) Dilute Sulphuric acid – 1.25 percent

(b) Sodium Hydroxide solution - 1.25 percent

(c) Ethyl alcohol – 95 percent

(d) Petroleum ether

Procedure

1. Weigh accurately about 2.5 - 3 gram defatted sample
2. Transfer the whole of the boiling acid to the flask containing the defatted material and immediately connect the flask with a water cooled reflux condenser and heat so that the contents of the flask begin to boil within 1 minute.
3. Since there is risk of foaming and bumping, add few drops of octanol after addition of sulphuric acid, in order to prevent foaming. Place boiling/glass beads in the flask, so as to prevent bumping of the sample.
4. Rotate the flask frequently taking care to keep the material from remaining on the sides of the flask and out of contact with the acid.
5. Continue boiling for exactly 30 minutes.
6. Remove the flask and filter through fine linen held in a funnel and wash with boiling water until the washings are no longer acid to litmus.
7. Bring to boil some quantity of sodium hydroxide solution. Wash the residue on the linen into the flask with 200 ml of boiling sodium hydroxide solution.
8. Immediately connect the flask to the reflux condenser and boil for exactly 30 minutes.
9. Remove the flask and immediately filter through the filtering cloth. Thoroughly wash the residue with boiling water and transfer to a Gooch crucible.
10. Wash the residue thoroughly first with hot water and then with about 15 ml of ethyl alcohol. Dry the Gooch crucible and contents at 105±2°C in an air oven until constant weight is achieved. Cool and weigh.

11. Incinerate the contents of the Gooch crucible in a muffle furnace until all carbonaceous matter is burnt.
12. Cool the Gooch crucible containing ash in a desiccators and weigh (Dry the crucible with its residues in an oven at 130^0 for 2 hours).

Observations:

1. Name of the sample: _____
2. Weight of sample: _____
3. W1 = wt in gram of Gooch crucible and contents before ashing: _____
4. W2 = wt in gram of Gooch crucible containing asbestos and ash: _____
5. W = wt in gram of the dried material taken for the test : _____

Calculation:

$$\text{Crude fiber percent by wt} = \frac{(W1 - W2)}{W} \times 100$$

Result:

EXPERIMENT NO. 6

Determination of total ash content of cereal grains

Objective: To determine the total ash content of cereal grains

Materials required: sample, crucible, muffle furnace

Procedure:

1. Take fresh sample for the determination, rather than left over after determination of moisture. Ignite the dried material in the dish with the flame of a burner till charred.
2. Transfer to a muffle furnace maintained at 550 – 600°C and continue ignition till grey ash is obtained.
3. Cool in a desiccators and weigh. Repeat the process of heating, cooling and weighing at half hour interval till the difference in weight in two consecutive weighting's is less than 1 mg.
4. Note the lowest weight.
5. If ash still contains black particles add 2-3 drops of pre-heated water at 60 degrees Celsius. Break the ash and evaporate to dryness at 100-110°C. Re-Ash at 550 °C. Until ash is white or slightly grey.

Observations:

1. Name of the sample:_____
2. Weight of sample: _____
3. W = Weight in gram of empty dish : _____
4. W1 = Weight in gram of the dish with the dried material taken for test:____.
5. W2 = Weight in gram of the dish with the ash: _____

Calculation :

Total ash on dry basis percent =

$$\frac{(W2 - W)}{(W1 - W)} \times 100$$

Result:

Determination of starch content of cereals.

Objective: To determine the starch content of cereals by anthrone reagent method

Relevant Information:

Starch is an important polysaccharide. It is the storage form of carbohydrate in plants abundantly found in root, tubers, stems, fruits and cereals. Starch which is composed of several glucose molecules, is a mixture of two types of components, namely amylose and amylopectin. Starch is a hydrolyzed into simple sugars by dilute acids and the quantity of simple sugars is measured colorimetrically.

Principle

The sample is treated with 80% alcohol to remove sugars and then starch is extracted with perchloric acid. In hot acidic medium starch is hydrolyzed to glucose and dehydrated to hydroxymethyl furfural. This compound forms a green coloured product with anthrone.

Reagents

1. Anthrone: Dissolve 200mg anthrone in 100ml of ice-cold 95% sulphuric acid.
2. 80% Ethanol
3. 52% Perchloric acid
4. Standard glucose: Stock-100 mg in 100ml water.

Working standard -10 ml of stock diluted to 100ml with water (100/µg/ml).

Procedure:

1. Homogenize 0.1 to 0.5g of the sample in hot 80% ethanol to remove sugars. Centrifuge and retai the residue. Wash the residue repeatedly with hot 80% ethanol till the washings do not give colour with anthrone reagent.
2. Dry the residue well over a water bath.
3. To the residue add 5.0 ml of water and 6.5 ml of 52% perchloric acid.
4. Extract at 0^0C for 20 min. Centrifuge and save the supernatant.
5. Repeat the extraction using fresh perchloric acid.
6. Centrifuge and pool the supernatants and make up to 100ml.

7. Pipette out 0.1 or 0.2 ml of the supernatant and make up to the volume to 1ml with water.
8. Prepare the standards by taking 0.2, 0.4, 0.6, 0.8 and 1ml of the working standard and make up the volume to 1ml in each tube with water.
9. Add 4ml of anthrone reagent to each tube.
10. Heat for 8 min in a boiling water bath.
11. Cool rapidly and read the intensity of green to dark green colour at 630 nm.

Calculation: Find out the glucose content in the sample using the standard graph. Multiply the value by a factor 0.9 to arrive at the starch content.

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. % starch content:_____

Result:

Germination of grains

Objective: To study the germination of grains

Relevant Information: Whole grain cereals have been found to be a good source of nutritionally valuable substances, such as antioxidants, minerals, vitamins, and dietary fiber. A wide range of these compounds are affected by germination. Therefore, germination and malting of cereals is a way not only to produce fermentable extract for the brewing and distilling industries, but can also be a way to produce ingredients enriched with health promoting compounds.

Materials required: grain sample, weighing balance, utensils, musline cloth

Procedure:

1. Take a known quantity of grains and clean it.Rinse seeds for one minute and add enough water to cover them.
2. Remove floating debris, possibly-contaminated fragments of the shells that may be floating around.
3. Sanitize the sprouting containers.
4. Soak the grains in bowl for 8 hours and change the water in between 2-3 times
5. After soaking arrange the grains on wet cloth and keep them in germinator at 20°C
6. Carry out germination till the sprouts develope by 1-2 inchs in length and record the observations

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. Weight of the germinated grains:_____
4. Weight of the no germinated grains:_____
5. Germination yield:_____
6. Length of sprouts :_____

EXPERIMENT NO. 9

Determination of cooking quality of rice

Objective: Determination of cooking quality of rice

Relevant Information:

The economic value of rice depends on its cooking and processing quality, which can be measured in terms of water uptake ratio, grain elongation during cooking, solids in cooking water and cooking time. Linear elongation of rice on cooking is one of the major characteristics of good rice. Some varieties expand more in size than others upon cooking. Length-wise expansion without increase in girth is considered a highly desirable trait of high quality rice. Soaked milled rice of high gelatinization temperature elongates less during cooking than low and intermediate gelatinizing rice. Thus, Gelatinization temperature correlates positively with grain elongation. By evaluating the grain quality characteristics such as cooking quality e.g. water uptake ratio, grain elongation, cooking time and solids in cooking water rice quality can be analyzed.

Materials required: rice sample, glass wares, prescise balance, water bath and burner

Procedure:

A. Water Uptake Ratio

1. Weigh 2.0 g of rice grain sample
2. Cook the rice grains in 20 ml distilled water for a minimum cooking time in a boiling water bath and draining the superficial water from the cooked rice.
3. Weigh the cooked samples accurately
4. The water uptake ratio was calculated as the ratio of final cooked weight to uncooked weight.

$$\text{Water uptake ratio} = \frac{\text{(weight of cooked rice)}}{\text{(Weight of uncooked rice sample)}}$$

B. Solids in Cooking Water

Procedure:

1. Weigh 2.0 g of rice grain sample
2. Cook the rice grains in 20 ml distilled water for a minimum cooking time in a boiling water bath and draining the superficial water from the cooked rice.

3. Take a weight of the empty petri dish and record as (W_1).
4. Add an aliquot of the cooking water in a tarred evaporating dish and weigh it(W_2).
5. Evaporate the water in the cooking water as steam*to dryness*
6. Then weigh the petri dish and the dry aliquot (W_3).
7. The amount of solid in cooking water calculated as:

$W_3 - W_1$; where

W_1 = weight of empty Petri dish, W_3 = weight of empty dish + dry aliquot

C. Cooking time

Procedure:

1. Weigh 2.0 g of rice grain sample
2. Boil the rice grains in 20 ml distilled water in a boiling water bath
3. Remove a few kernels at different time intervals during cooking and press them between two glass plates until no white core was left.
4. Optimum cooking time was taken as the established cooking time plus two (2) additional minutes.

D. Grain Elongation ratio during Cooking

1. This can be determined by first measuring the initial grain length (L_0) before cooking.
2. The final length (L_1) after cooking was then measured.
3. The grain elongation ratio during cooking was then calculated as:

L_1/L_0,

Where L_0 = initial grain length before cooking

L_1 = final length after cooking.

Observations:

1. Name of the sample:_____
2. Initial weight of the sample:_____
3. Weight after cooking:_____
4. Amount of water absorbed/Water uptake ratio:_____
5. Solids in cooking gruel:_____
6. Grain elongation ratio :_____
7. Cooking time:_____

Result:

EXPERIMENT NO. 10

Determination of functional properties of cereal grains

Object: To determine the functional properties of cereal grains

Relevant Information:

Functional properties are those parameters that determine the application and end use of food materials for various food products. The application of flour or starch in food production and in the industry depend on various functional properties such as dispersibility, water absorption capacity, pasting, retro-gradation, viscosity, swelling power, solubility index etc.Functional properties determination will provide the useful information to industry purpose and other alike on the subsequent incorporation of the different flours along with wheat flour to produce natural, cheap and acceptable functional foods.

Materials Required:

Sample, glass wares, centrifuge etc.

Procedure:

A. Swelling power and solubility index determination

1. Sample preparation: Maize,Rice,Millet, and Sorghum, sorted, washed, dried at 70°C in a dryer and milled. The flour samples were sieved using 250μm mesh size and were used for the following analyses.
2. One gram of sample was poured into pre-weighed graduated centrifuge tube appropriately labeled.
3. Then, 10 ml of distilled water was added to the weighed sample in the centrifuge tube and the solution was stirred and placed in a water bath heated at different temperature range (55, 65, 75, 85, 95 °C) for 1 h while shaking the sample gently to ensure that the starch granules remained in suspension until gelatinization occurred.
4. The samples were cooled to room temperature under running water and centrifuged for 15 min at 3000 rpm.
5. After centrifuging, the supernatant was decanted from the sediment into a pre-weighed petri-dish; the supernatant in the petri-dish was weighed and dried at 105 °C for 1 h.
6. The sediment in the tube was weighed and the reading recorded.
7. The starch swelling power and solubility was determined according to the equations below;

$$\text{swelling power} = \frac{\text{weight of swollen sediment}}{\text{weight of dry starch}} \times 100$$

$$\text{Solubility} = \frac{\text{weight of dry supernatant}}{\text{weight of starch sample}} \times 100$$

Observations:

1. Name of the sample : _____
2. Weight of sample : _____
3. Weight of swollen sediment : _____
4. Weight of dry supernatant : _____
5. Weight of starch sample : _____

B. Water absorption capacity determination:

Procedure:

1. Weigh sample of 1g into clean pre-weighed dried centrifuge tube and mix with 10 ml distilled water with occasional stirring for 1 hr.
2. Centrifuge the dispersion at 3000 rpm for 15 min.
3. After centrifuging, decant the supernatant and weigh the tube with the sediment after removal of the adhering drops of water.
4. The weight of water (g) retained in the sample determined as WAC.

Observations:

1. Name of the sample: W_____
2. Weight of sample: _____
3. Weight of empty centrifuge tube: W_1_____
4. Weight ofcentrifugetube with the sediment without water: W_2_____

Calculation:

$$\text{Water absorption capacity: } \frac{(W_2 - W_1) - W}{W}$$

C. Dispersibility determination

1. Weigh 10 gram sample
2. Disperse the sample in50 ml distilled water in a measuring cylinder
3. Stirthe mixture vigorously and settle for 3 hr.
4. Note the volume of settled particles and calculate the percentage dispersibility as follows:

$$\text{Dispersibility (\%)} = \frac{(50 - \text{Volume of settled particle})}{50} \times 100$$

Observations:

1. Name of the sample: W_____
2. Weight of sample: _____
3. Volume of distilled water in a measuring cylinder V_1_____
4. Volume ofsettled particles: V_2_____

Calculation:

$$\textbf{Percent Dispersibility} = \frac{(V_1 - V_2)}{V_1} \times 100$$

Result:

EXPERIMENT NO. 11

Study of gelatinization of starch

Objective:

To Study of gelatinization of starch

Relevant Information: Starch is one of the most important polysaccharides and is a major component of many food plants such as wheat, barley, rice, corn, potato, sweet potato and cassava. Starch is used in food, cosmetics, paper, textile, and certain industries, as adhesive, thickening, stabilizing, stiffening, and gelling (pasting) agents. Starch consists of amylose and branched amylopectin molecules in molar ratios of 15% - 25% and 85% - 75%, respectively.

1. Gelatinization of starch

Gelatinization occurs when starch granules are heated in a liquid. It is responsible for the thickening of food systems. The process is an important physic-chemical change associated with the cooking of starchy materials. When the liquid is heated, the hydrogen bonds holding the starch together weaken, allowing water to penetrate the starch molecules, causing them to swell until their peak thickness is reached. During the gelatinization, water will be absorbed into the individual starch granules and held there tightly, actually becoming bound water. Bound water is no longer able to flow; the water that is bound in the granules causes granule themselves to swell significantly. The gelatinized starch mixtures are opaque and the ordered crystalline structure of starch is lost. Gelatinization takes place over a temperature range that varies according to the source of starch and its amylose / amylopectin ratio.

2. Gelatinization temperature:

The time required for cooking rice is determined by its gelatinization temperature. Gelatinization temperature is the temperature at which the rice absorbs water and starch granules swell irreversibly. Gelatinization temperature can be determined by amylo-graphic procedure.Based on gelatinization temperatures, milled rice is classified as low, intermediate, and high gelatinization rice.

Low gelatinization rice: Varieties with a gelatinization temperature below 70°C. Most Japonica varieties have a low a gelatinization temperature. Preferred for baby foods, specific brewing uses, and many dry breakfast cereals.

Intermediate gelatinization rice: Varieties with a gelatinization temperature between 70°-74°C. Most tropical Indica varieties have intermediate or low gelatinization temperatures. Are the characteristics of typical cooking long grain varieties.

High gelatinization rice: Varieties with a gelatinization temperature greater than 74°C. If gelatinization rice is very high, then the rice will become excessively soft and disintegrate when overcooked. It will also require more cooking and water than rice with a lowe gelatinization rice and are generally considered undesirable for most cooking and processing uses.

The gelatinization temperature can be judged by alkali spreading test .The degree of spreading of individual milled rice kernel in a weak alkali solution (1.7% KOH) at room temperature (32±2°C) was evaluated on a 7-point numerical scale. Grains swollen to the extent of a cottony center and a cloudy collar were given an alkali spread value (ASV) score 4 and used as check for scoring the rest of the samples in the population. Grains that were un-affected were given ASV of 1 and grains that were dispersed and disappeared completely were given a score of 7. A low ASV corresponds to a high gelatinization temperature; conversely, a high ASV indicates a low gelatinization.

Procedure:

1. Take 6 g healthy and sound seed and place them in Petri dish.
2. Add 15 ml of 1.7% KOH Solution
3. Cover Petri plate with black carbon paper
4. Keep overnight. Degradation is observed by hardness at center of grain.
5. Some varieties remain with intact with hard center and they do not lose their shape.
6. In some varieties a small thin film over the rice is observed, where upper layer is disintegrated & lose shape & size. Few varieties get disintegrated completely and become stickier.
7. Observe the alkali degradation and calculate alkali spread value (ASV) score and determine the gelatinization temperature.

Observations:

1. Name of the sample : _____
2. Initial weight of the sample : _____
3. Alkali spread value (ASV) score : _____
4. Gelatinization temperature : _____

Result:

EXPERIMENT NO. 12

Determination amylose content in rice

Objective: To determine amylose content in rice

Relevant Information:

Amylose content in rice is considered the single most important characteristic used in describing & predicting rice cooking and processing qualities. If Amylose content is high, the rice grains will show high volume expansion (not necessarily elongation) and a high degree of flakiness. The rice grains cook dry, are less tender, and become hard upon cooling. And if Amylose content is low, the rice grains will cook moist and sticky. Based on amylose content, milled rice is classified as low, intermediate, and high.

1. Low: 10-20% amylose content is classified as Low. (Short grain variety)
2. Intermediate: 20-25% amylose content is classified as Intermediate. Intermediate amylose rice is preferred in most rice-growing areas of the world except where low-amylose japonicas are grown. (Medium grain variety)
3. High: 25-30% amylose content is classified as High. (Long grain variety)
   Glutinous or waxy varieties contain virtually no amylose.

Principle:

The iodine is absorbed within the helical coils of amylose to produce a blue colored complex which is measured colorimetrically.

Material Required: Distilled ethanol, 1N NaOH, 0.1% phenolphthalein, Iodine reagent – dissolve 1g iodine and 10g KI in water and make up to 500 ml, Standard – dissolve 100 mg amylose in 10 ml 1N NaOH; make up volume to 100 ml with water.

Procedure :

1. Weigh 100 mg of the powdered sample, and add 1 ml of distilled ethanol, then add 10 ml of 1N NaOH and leave it overnight.
2. Make up volume to 100 ml.
3. Take 2.5 ml of the extract, add about 20 ml distilled water and then three drops of phenolphthalein.

4. Add 0.1N HCl drop by drop until the pink colour just disappears.
5. Add 1 ml of iodine reagent and make up the volume to 50 ml and read the colour at 590nm.
6. Take 0.2, 0.4, 0.6, 0.8 and 1 ml of the standard amylose solution and develop the colour as in the case of sample.
7. Calculate the amount of amylose present in the sample using the standard graph.
8. Dilute 1 ml of iodine reagent to 50 ml with distilled water for a blank.
9. Calculate the % amylose as follows,

Absorbance corresponds to 2.5 ml of the test solution= x mg amylose

100 ml contains= x/2.5 x 100mg amylose

= % Amylose

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. % amylose:_____

Result:

EXPERIMENT NO. 13

Determination of fat acidity of cereals

Objective: To determine the fat acidity of cereals

Relevant Information: Natural fats are mixtures of esters of fatty acids with glycerol. They are essentially neutral. Unfavorable storage conditions may cause partial hydrolysis of the glycerides. The resultant free fatty acids increase the acidity, which is an indication of deterioration in quality. Fat acidity is a sensitive and important parameter to determine the cereal product quality. It can be an indicator of biochemical changes during storage of cereal products. This method determines total fatty acids in grain and grain products by a general titrimetric procedure.

Fat acidity: conventional term used to express the quantity of acids, essentially non-esterified fatty acids. Fat acidity is expressed in milligrams of potassium hydroxide per 100 g of dry matter. It can also be expressed in milligrams of sodium hydroxide per 100 g of dry matter.

For most accurate results, moisture content of grain should not exceed 11.0%.Higher percentages of moisture at time of extraction have been found to raise fat acidity values significantly.

Materials required: cereal flours, glass wares

Apparatus

1. Laboratory mil
2. Fat-extraction device; Soxhlet apparatus

Reagents

1. Petroleum ether; boiling range 35–60°.
2. Toluene-alcohol-phenolphthalein (TAP) solution. Mix equal parts by volume of chemically pure toluene and 95% ethyl alcohol. Add 0.2 g phenolphthalein per liter to form 0.02% solution.
3. KOH CO2-free standard solution, 0.0178N (1 ml = 1 mg KOH).
4. Color standards: The intensity of yellow color in grain varies, depending on type of grain;therefore, a color standard is helpful in making titration end points uniform.

Prepare as follows: To 50 ml water in conical flask, add drop wise 0.05% potassium dichromate until water solution matches in color the grain extract solution to be titrated. Add 2.5 ml freshly prepared 0.01% potassium permanganate solution and mix. Color of titration end point should match this standard. Prepare color standard for titration blank by adding 2.5 ml 0.01% potassium permanganate to 50 ml water.

Procedure

1. Grind at least 40 g of representative sample of small grains such as wheat,or 200 g of larger grains such as corn. Once ground, sample must be carried to extraction step within 1 hr to forestall changes caused by lipolytic enzymes.
2. Extract 10 g ground sample with petroleum ether in extractor at rate of one siphoning about every 3 min. Extract approximately 16 hr.
3. Evaporate petroleum ether from extract and re-dissolve extract in extraction flask with 50 ml TAP solution.
4. Titrate extract solution with 0.0178*N* KOH to end point matching color of standard described under reagents.
5. Determine blank by titrating 50 ml TAP solution to end point matching color of standard for titration blank described under reagents.

Note

In the case of grain having high fat-acidity values, emulsions are sometimes formed during titration, partially masking the end point. When emulsion appears,50 ml additional TAP solution may be added to ensure a clear solution for titration. The blank titration value in this case must be double that determined on the single 50-ml portion of solvent.

Calculation

Report fat acidity as mg KOH required to neutralize free fatty acids from 100g grain on dry-matter basis by formula:

$$\text{Fat acidity value} = \frac{(T\text{-}B) \times 10 \times 100}{100\text{-}W}$$

where T = ml 0.0178N KOH required to titrate sample extract, B = ml 0.0178N KOH required to titrate blank, W = g water in 100 g of sample.

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. Ml of KOH required for sample:_____
4. Ml of KOH required for blank:_____
5. Moisture of the sample:_____
6. Fat acidity value:_____

Result:

EXPERIMENT NO. 14

Phenol test for cereals

Objective: To study the phenol test for cereals

Relevant Information:

It is a quick chemical test used to differentiate between some cultivars of wheat , barley, and oat. It is based on the color reaction between phenol solution and the seed coat of various cultivars.The Phenol Test is based on a color reaction between the phenol solution and the seed coat (pericarp) of the wheat seed. The test can also indicate purity, because the reactions of grains are shown individually. However, the distinguishing ability of the test is limited to only three or four categories of color reaction. Its suitability thus depends on the range of reactions of the specific varieties being considered. The phenol test helps in the verification of identity and the identification of contaminating grains.

Materials required: Cereals, Petridish, Phenol, Filter paper

Procedure:

1. There are two procedures available for phenol test of cereals:

   The rapid test : In the rapid test, soak dry grains in 1% phenol solution for about three minutes, and spread the grains on absorbent paper moistened with 1% phenol solution containing 0.25% ammonia .

   The traditional test: For the traditional method, soak grains overnight (or for at least four hours) in water, blot off excess water, and spread them on absorbent paper (e.g.,Whatman No.1 filter paper) moistened with 1% phenol solution. Cover the container and await color development for four hours at 25° C, 2.5 hours at 40° C, or 1.5 hours at 50° C.

2. Major differences in reaction are evident after 15 minutes at 25° C (or 10 minutes at 40°C); full coloration develops after 30-40 minutes at 25°C (or 20-30 minute at 40°C).

A B

Fig. 1. Phenol test: Uniform color reaction in a genetically pure wheat variety (A), and a mixture of color reaction in a sample containing more than one variety (B).

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. Color changes in the sample:_____
4. Phenol test :_____

Result:

Determination of Sedimentation value

Objective: To determine the sedimentation value of wheat flour

Relevant Information:

The sedimentation test provides information on the protein quantity and the quality of ground wheat and flour samples. Positive correlations were observed between sedimentation volume and gluten strength or loaf volume attributes. The sedimentation test is used as a screening tool in wheat breeding as well as in milling applications. The sedimentation test is conducted by holding the ground wheat or flour sample in an acid solution. During the sedimentation test gluten proteins of ground wheat or flour swells and precipitate as a sediment. Sedimentation values can be in the range of 20 or less for low-protein wheat with weak gluten to as high as 70 or more for high-protein wheat with strong gluten.

Materials required: wheat flour, measuring cylinder, Lactic acid solution

Procedure:

1. A small sample of flour or ground wheat (3.2 grams) is weighed and placed in 100-milliliter glass-stoppered graduated cylinder.
2. Water (50 milliliter) is added to the cylinder and mixed for 5 minutes.
3. Lactic acid solution is added to the cylinder and mixed for 5 minutes.
4. The cylinder is removed from the mixer and kept in upright position for 5 minutes.
5. The sedimentation volume is recorded.

Observation:

1. Name of the sample:_____
2. Initial Weight of the sample:_____
3. sedimentation volume:_____

Result:

EXPERIMENT NO. 16

Milling of cereal grains

Objective: To study modern rice milling

Relevant Information:

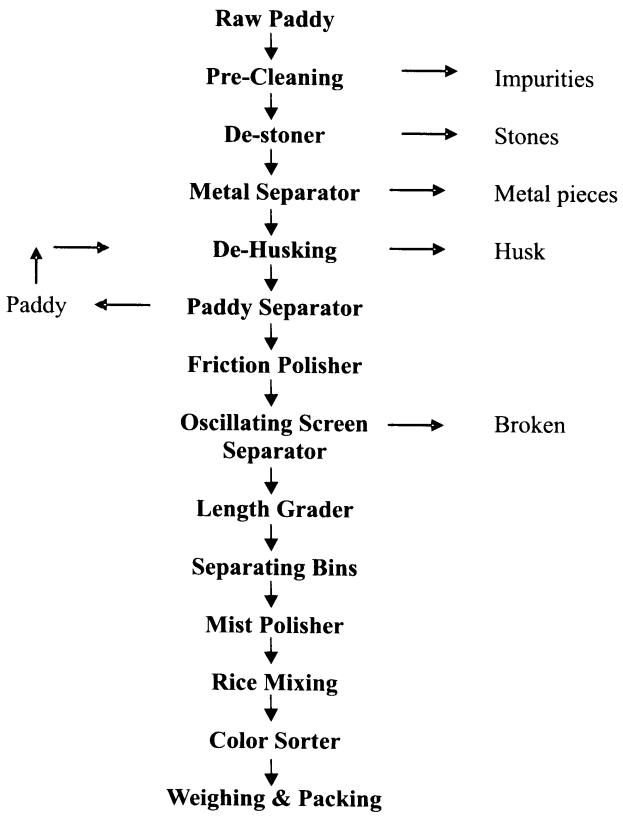
Rice milling is the process of removing the husk and bran layer to produce white rice.

Rice milling can be undertaken as:

- A one step milling process where the husk and the bran are removed in one pass and white rice is produced directly from the paddy.
- A two-step process where the husk and the bran are removed separately, and brown rice is produced as an intermediate product.
- A multistage process where rice passes through a number of different operations and machines from paddy to white rice.

Procedure:

Flow Diagram of Modern Rice Milling



Result :

EXPERIMENT NO. 17

Visit to milling industry