



**NATIONAL UNIVERSITY OF LIFE
AND ENVIRONMENTAL SCIENCES
OF UKRAINE**

Agrobiological Faculty

*Department of storage, processing and standardization of plant product
after prof. B.V. Lesik*

Handbook

*to the subject: “Storage and processing
technologies of crop products”
for the students’ Training direction
“Agronomy”*



Kyiv-2023

USC 631.56 (076)

Handbook to the subject: “Storage and processing technologies of crop products” for the students’ training direction “Agronomy”. Handbook include theory and methodologies of grain quality determination. These Handbook contain requirements of standards to grain different crops quality and included the list of references.

Recommended by Learned Councils of Agrobiological Faculty of National University of Life and Environmental Science of Ukraine.

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Handbook to the subject: “Storage and processing technologies of crop products” for the students’ Training direction “Agronomy”

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Publishing «Centre of information technologies»
Kikvidze St., 43, Kyiv, 01103

Signed for publication 15.09.2023
Format 60x84 1/16
Con. printer's sheet 4.5. Tally sheet 5.1
Quantity 100 copy. Order. №258.

Introduction

For many years' cereal scientists and technologists have been trying to define, understand and measure wheat quality. Among cereals wheat is a unique grain crop for milled flour is capable to make a light, palatable, well-risen loaf of bread when processed into fermented dough. It is the insoluble storage proteins of wheat, collectively called "gluten", that give wheat its functional properties. Gluten has been described as the most complicated theological material known to a man. Rheology is the study of viscoelastic materials: gluten has some of the properties of viscous materials, notably flow, and some of the properties of elastic materials which stretch under stress and spring back when tension is relaxed. It is chemically complex because it is made up of hundreds of different protein subunits which aggregate to form extremely large molecules when made into dough. The presence or absence of specific proteins may well determine whether a variety has "good" or "poor" baking quality or whether it is "weak" or "strong". It is gluten that gives dough its ability to form thin sheets that will stretch and hold gas. Even relatively poor quality wheal can produce bread that is significantly more palatable than that made from flour from other cereal grains.

In order to become more discerning and match suitability for bread-making with wheat quality, we should first consider the three basic quality factors that determine wheat type. These are hardness, gluten strength and protein content. In general, soft wheat with weak gluten and low protein content are not suitable for bread-making, hard wheals with strong gluten and high-protein content are preferred.

Lesson 1. Spot samples selection, forming united samples and average daily samples

The basic concepts of the standard “Rules of acceptance”.

Quality is the complex of characteristics and product properties which are capable to satisfy requirements of the consumer in dependence on destination.

The consignment of grain is the certain weight of grain with homogeneous quality which has one destination and one quality certificate.

Spot sample of grain is the sample selected from one place of a consignment of grain at once. The weight of one spot sample should not be less than 100 g.

United sample is the amount of grain spot samples.

Average daily sample is the sample formed from united samples selected from consignments of grain with homogenous quality which obtained from one enterprise during one day.

Average sample is the sample selected from a united sample or an average daily sample to determine the quality of grain. The weight of average sample of grain is 2 kg plus or minus 100 g.

Sample is the certain weight of grain selected from an average sample for determination of one index of grain quality.

Procedure of grain receiving in grain enterprises.

Before grain receiving in grain-collection it is checked by laboratory. Each consignment of grain is estimated by organoleptic. If consignment is homogeneous by organoleptic, then select spot samples, forming united sample, will test it and finally evaluate the quality of grain.

If consignment of grain has non-specific smells or infestation by barn pests (admitted infestation of grain only ticks the first or second degree), will not select united sample and grain will return to an economy. In other cases, spot samples are taken from the consignment of grain. Spot sample of grain is the sample selected from one place of a consignment of grain at once. Spot samples selected by special devices so-called samplers. There are manual and mechanical samplers. Manual samplers are conical, cylindrical, bag-trier, hand scoop, grain probe (fig. 1). Mechanical ones are pneumatic probe sampling unit, А1-УП2-А, ПДШ, ППД (fig. 2).

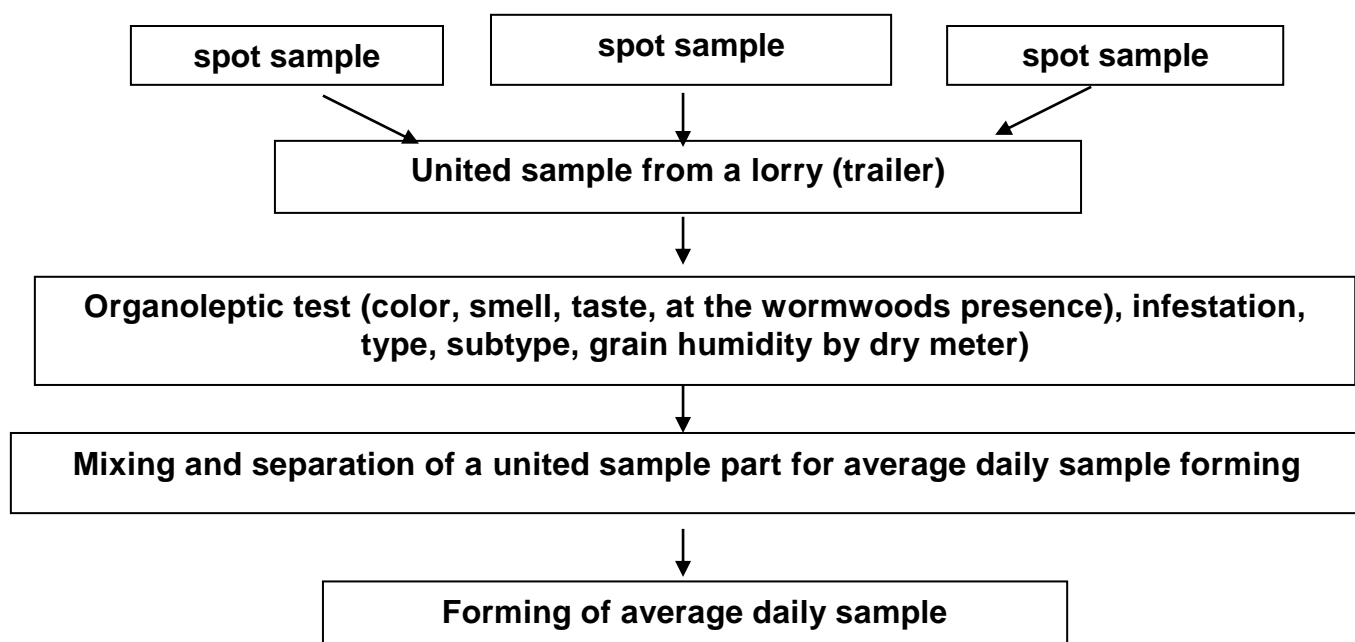
The amount spot samples of grain name a united sample. The united sample poured out in the pure vessel uninfected by pests and hermetically closes it. The label with the indication of crops names, number of the lorry, a granary, weight of a consignment, time of sample selection and its weight is added to the vessel. The label is signed by a person who selected samples. In the united sample it is most correctly to determine organoleptic indexes of grain and its infestation by barn pests. Than determines type, subtype of grain and humidity by dry meter.

After carrying out of all analyses an average sample of grain is kept in a laboratory during one day. If consignment of grain intends for sending to other places, it is necessary to keep it within a month, and the grain intends on export – within three months by railway and six months – by sea.

Payment of the accepted consignment of grain is carried out depending on grain quality of average daily sample. Average daily sample is the sample formed from united samples selected from every consignment with homogenous quality which come from one economy during one day.

On the formation average daily sample from every united sample we take 50 g from each ton of grain which arrived.

Scheme forming an average daily sample from a lorry.



The results of analyses are written down in a laboratory journal which is transferred to account department for carrying out of calculations for the accepted grain.

Conformity of grain quality to requirements of the standard is determined by an average sample. Average sample is the sample selected from a united sample or an average daily sample using the method of squares (fig. 3) or with using device BIS-1 (fig. 4). The weight of average sample of grain is 2 kg plus or minus 100 g.

Method of squares. Grain pours out on a flat surface in the form of square and mixed with use of two wooden boards. We should collect grain from the opposite sides by both hands, pour grain in the center of a square in the form of a roller, then take grain from the opposite sides of a roller and simultaneously pour it to the center of a square. You should mix grain three times. Then a sample again scattered out on a flat surface in the form of square and is divided by wooden boards diagonally on four triangles. Grain from two opposite sides is thrown out and the rest of grain again is distributed till it will reach the weight of 2 kg plus or minus 100 g.

The device BIS-1 is used for grain mixing to divide an average daily sample or united sample on a half and to select samples of certain weight (25, 50, 100).

Quantities of spot samples depend on the weight of grain consignment and ways of grain storage and transportation.

The consignment of grain transported by lorry (bread van). The consignment of grain transported by lorry or bread van will be taken depend on the length of a lorry.

| Length of a lorry body | Quantity of spot samples | Weight of spot samples |
|------------------------|--------------------------|------------------------|
| Up to 3.5 m | 4 spot samples | Do not less 1 kg |
| From 3.5 till 4.5 m | 6 spot samples | Do not less 1.5 kg |
| 4.5 and more m | 8 spot samples | Do not less 2 kg |

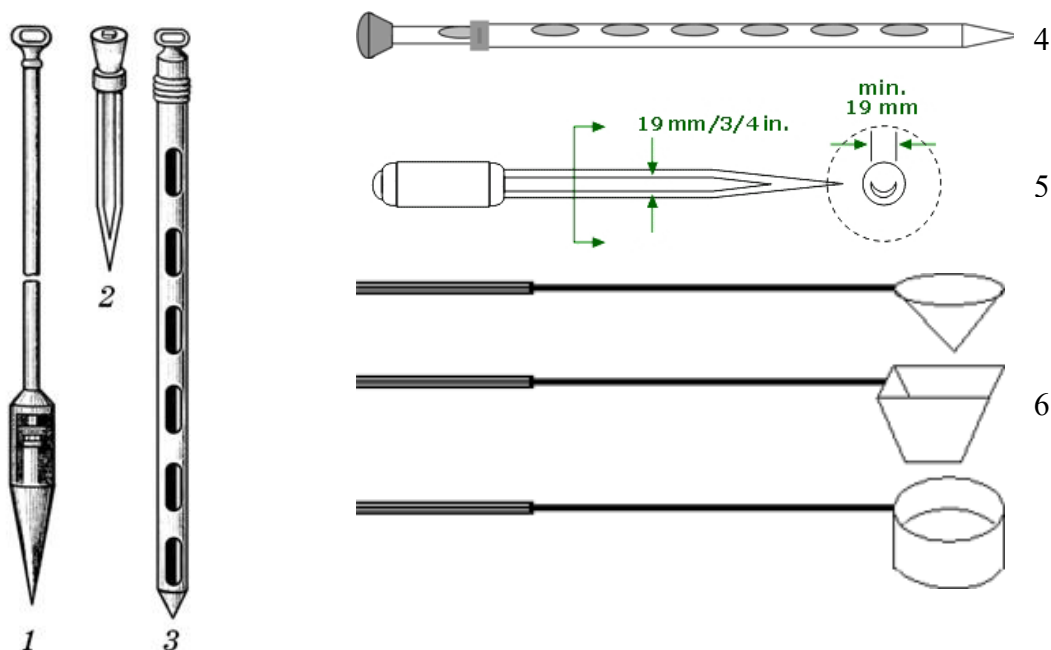


Fig. 1. Manually samplers: 1 – conical; 2, 5 – a bag-trier; 3, 4 – grain probe; 6 – a hand scoop

The grain in the bags. Spot samples from consignment of grain in bags are taken depend on the quantity of bags. If a consignment of grain is up to 10 bags, then spot samples of grain will be taken from every second bag. If a consignment of grain is from 10 till 100 bags the spot samples will be taken from every 5-th bag plus 5 % from total bags in a consignment. If a consignment of grain is more than 100 bags the spot sample will be taken from every 10 bag plus 5 % from total bags in a consignment. Sport samples are taken from the bags at 3 levels: top, middle and bottom.

The grain storage in a bulk. The grain bulk divides into sections 100 or 200 square meters.

| Section area | Quantity of spot samples | Weight of spot samples |
|--------------------|--------------------------|------------------------------|
| 100 m ² | 4 spot samples | Their weight don't less 2 kg |
| 200 m ² | 6 spot samples | Their weight don't less 2 kg |

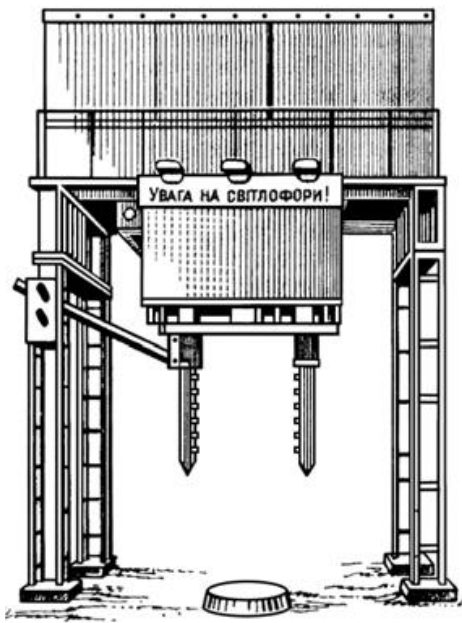


Fig. 2. Mechanical samplers: 1 – A1-УП2-А; 2 – a pneumatic probe sampling unit

Spot samples are taken from the top and bottom layers of grain bulk by manual samplers and on all depth of bulk – by mechanical samplers. If the thickness of grain bulk is up to 1.5 m spot samples are taken from the top and bottom layers of bulk. If the thickness of grain bulk is more than 1.5 m spot samples are taken from the top, middle and bottom layers of bulk. Sport samples from grain bulk are taken from the bulk border not less than 1 meter.

Order selection of spot samples from consignment of grain which loads and unloads into a carriage, a steamboat and an elevator. Spot samples from consignment of grain which loads and unloads into a carriage, a steamboat and silos of elevator are taken from a stream of grain by a hand scoop interrupt stream of grain during equal interval of time. Quantities of spot samples are depending on velocity loading of grain, weight of grain consignment and content of admixture in grain (tab. 2).

Table 2 – Quantities of spot samples depending on the weight of grain consignment and admixture content in grain

| Weight of grain consignment, t | Quantities of spot samples | |
|--------------------------------|---|--------------------------------------|
| | low and average content of admixture in grain | height content of admixture in grain |
| Up to 100 | from every 3 | from every 3 |
| 101–200 | from every 5 | from every 5 |
| 201–400 | from every 10 | from every 5 |
| 401 and more than | from every 20 | from every 10 |

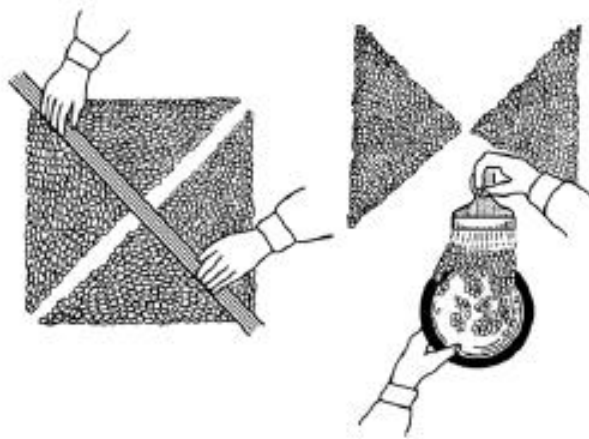


Fig. 3. Method of squares

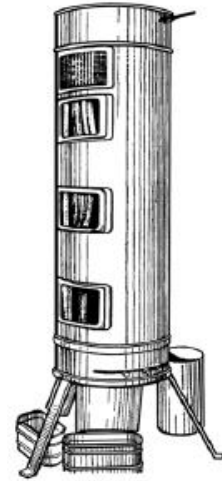


Fig. 4 Device BIS-1

Questions to the lesson.

1. What is a consignment of grain?
2. What is a spot sample of grain?
3. What is a united sample?
4. What is an average daily sample?
5. What is an average sample?
6. What is a sample?
7. Write down weight of a spot sample
8. Write down weight of an average sample?
9. Order selection of spot samples from a grain consignment on the lorry.
10. Order selection of spot samples from a grain consignment in a bulk.
11. Order selection of spot samples from a grain consignment in the bags.
12. What samplers do you know? Principles of their work.
13. What is the device BIS-1 used for?
14. Terms of keeping an average sample in a laboratory.

Lesson 2. Determination of grain freshness.

Organoleptic (freshness) indexes of the soft wheat according standard.

Condition - Non self-heating and in healthy condition.

Smell - Correspond to normal wheat grain without musty, malty, mouldy and other subsidiary smell.

Colour – Normal, correspond to the colour grain the certain type; allowed the 1-st till 3-d degrees of discoloration depend on the grain class.

Methods of colour, smell and taste determination.

Colour. The colour of grain is determined at scattered daylight comparing with etalon.

Smell. The smell is determined in the whole and the milling grain. From a preliminary mixed average sample of grain take about 100 g on a palm, warm it by breath and test it on a smell. For intensify the smell put grain in a glass, fill it by hot water (60-70 °C), cover by glass and leave it for 2-3 minutes. Pour out the water and investigate grain on a smell.

Taste. Take about 100 g of grain from an average sample, clear it from impurity and milling. Mix 50 g of ground grain with 100 millilitre of distilled water and pour out it in a vessel with 100 millilitres of boiled water, mix them and cover by glass. The taste of a mixture is determined after it cools down to 30-40 °C.

Possible changes of grain colour.

The grain has specific colour and shine that are corresponding to the botanical particularity of certain crops: a sort, a kind and a type.

The changing of specific colour for grain is the first attribute of unfavourable conditions of ripening, storage or technology receptions and handling of grain. So, grain gets greenish colour if it has influence on a frost or it is unripe. It called frost-shattered or unripe.

Grain gets dark colour due to the long influence on precipitation at the time of harvesting and development of self-heating. The grain damaged by a corn-bug has light yellow spots on a surface. Grain lost characteristic shine of surface that indicated on the development of microorganisms. Partially germination grain and grain with high humidity becomes dim and discoloration. The grain damaged by drying (roasted) or self-heating becomes reddish colour of different shades from dark-brown to mat-red without shine.

As a result, in unfavourable conditions of ripening, harvesting and storing, grain lost its nature colour and definition as “grown dark” (for the presence of dark shades) or as “discoloration”. There are 3 degrees of discoloration.

Taste of the spoiled grain.

The taste of normal grain express poorly. Sweet taste arises owing to germination of grain and the vigorous activity of amylase enzymes that transform starch to dextrin and sugar. Frost-shattered and unripe grain can also have sweet taste. Boxes of wormwood that contain such bitter substance as absintin gives a bitter taste to grain. Mouldy (sour) taste appears owing to development of a mould in grain.

Possible smells of grain and the reasons of their origin.

Healthy grain of each crop has a characteristic smell. There are 2 groups of grain smell. There are sorption smells and smells of disintegration (tab.4).

Table 4 – Possible smells of grain and the reasons of their origin

| | |
|---------------------|--|
| The sorption smells | Garlic, wormwood, smut, mineral oil, smoky and other smells. It is possible washing and drying of grain to get rid wormwood, garlic and smut smells. The grain with other sorption smells does not acceptance. |
|---------------------|--|

| | |
|------------------------------|---|
| The smells of disintegration | Barn, malt, mouldy and decay smells apply to disintegration smells. The barn smell appears to long storage of grain without aeration. It can be removed by ventilation. The grain with a barn smell is allowed to accept. Malt smell gets grain to self-heating and germination. The grain with a malt smell is allowed to accept as a result of permission of Cabinet Council of Ukraine with discount from price up to 30 %. A mouldy smell can appear owing to development of mould fungi in grain with high humidity. A decay smell can appear owing to disintegration of organic substances to mineral (ammonia and etc.). The grain with mouldy and decay smells does not accept. |
|------------------------------|---|

Questions to the lesson.

1. What are freshness indexes of grain do you know?
2. Tell about a procedure determine of grain colour.
3. Tell about a procedure determine of grain smell.
4. Tell about a procedure of grain taste determination.
5. What changes of grain colour do you know? The reasons of their appearing.
6. What sorption smells do you know? The reasons of their appearing. What sorption smell can be removed?
7. What disintegration smells do you know? The reasons of their appearing. What disintegration smell can be removed?
8. What changes of grain taste do you know? The reasons of their appearing.

Lesson 3. Determination of grain infestation

Norms of standards to grain infestation by barn pests.

The basic barn pests which infected wheat are weevils, ticks, moth and etc., peas - peas weevils (Bruchidae) and leaf roller.

Detecting infestations. You can detect signs of an infestation by knowing about the life stages of insect pests.

Beetles and moths, the most common stored-product insect pests, have the following four stages (fig. 5 and fig. 6):

- egg;
- larva;
- pupa;
- adult.

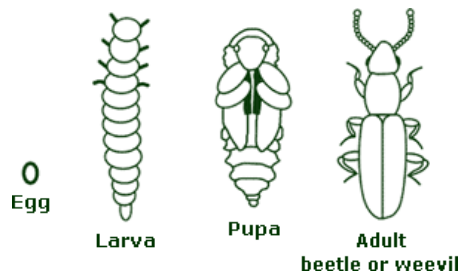


Fig. 5. Four stages of beetles

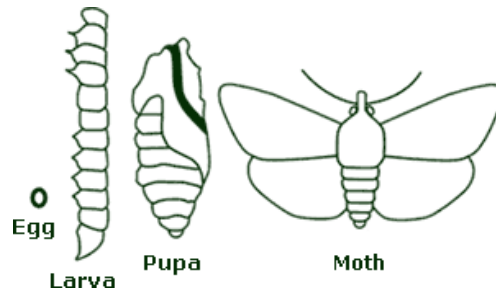


Fig. 6. Four stages of moths

Egg. Eggs may be laid either in the crevices of kernels or in dust and refuse within bins. Some species, such as granary weevils, lay their eggs inside kernels.

Larva. The larva is the only stage during which the insect grows. It consumes several times its own weight in food, and, as the larval skin cannot stretch, it periodically molts allowing it to increase in size. Cast-off skins found in grains and oilseeds and their products indicate that insects are, or were, present.

Pupa. The pupa that is formed after the last larval molt does not feed. In some species, the pupa is enclosed in a cell, or a cocoon, constructed by the larva. During the pupal stage, the insect undergoes extreme internal and external changes that lead to the development of the adult.

Adult. Adults of stored-product insects are between 0.1 and 1.2 centimetres long. They have three pairs of legs, and their bodies are divided into three parts:

- the head includes the mouthparts and sense organs;
- the thorax bears the legs and wings;
- the abdomen contains the reproductive organs.

Adults move in spaces between kernels and can penetrate deeply into a pile of grains or oilseeds, with the exception of moths and spider beetles. Some stored-product insects can fly and are widely distributed. Beetles have poorly developed wings and some species are unable to fly, although the rusty grain beetle and the red flour beetle can fly well.

Booklice and mites have egg, nymph and adult stages (fig. 7). There is no larval stage.

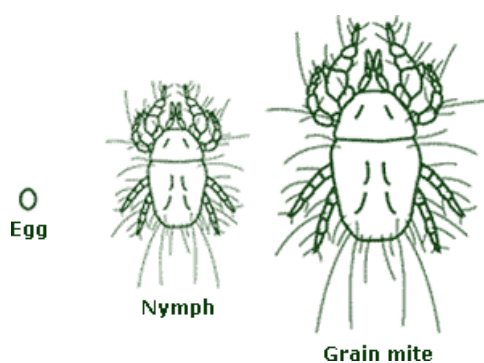


Fig. 7. Stages of mites

Life cycles of stored-product insects (beetles and moth) is presented on fig. 1 (Appendix 4). Some major stored product mites as viewed by scanning electron microscope are presented on fig. 2 (Appendix 4).

Insects identifying. Before taking remedial action it is important to determine which species of insect pests are present in grain. Many insects appear similar but have different behaviour and status as pests. Their presence may indicate different conditions. The insects in the examples below look similar to each other. Stored-product beetles, moths and mites are presented in the Appendixes 5-6.

Requirements of standards to infestation by barn pests.

Infestation of grain by barn pests according of standards is not admitted for any purposes except infestation by ticks of 1-st and 2-d degree at a discount from price of 0.5 %. Quantity of pests depends of degree grain infestation by ticks and weevils presented in the table 5.

Table 5 – The degrees of grain infestation by ticks and weevils

| Degrees of infestation | Quantity in 1 kg of grain, pieces | |
|------------------------|-----------------------------------|---|
| | weevils | ticks |
| 1-st | From the 1st to the 5th include | From the 1st to the 20th include |
| 2-d | From the 6th to the 10th include | More than the 20th that are free-moving but do not create the concentration |
| 3-d | More than 10th | Ticks are create the concentration |

Forms of grain infestation and methods determination of grain infestation by pests.

There are two forms of grain infestation by pests: obvious and hidden. The obvious form of infestation is presence of alive pests in all stages of development in intergrain spaces. Pests can be seen with unaided eye or by magnifying glass. The hidden form is presence of alive pests in all stages of development in the inside grain and can be determine them only by tool methods.

Determination of pests at the obvious form. Total average sample is used for determination. The grain is sifted through the sieves with hole of 2.5 and 1.5 mm manually during 2 min with intensity of 120 circular movements per 1 min or mechanically by the PVZ device (fig. 8) during 1 min at 150 circular movements per 1 min.

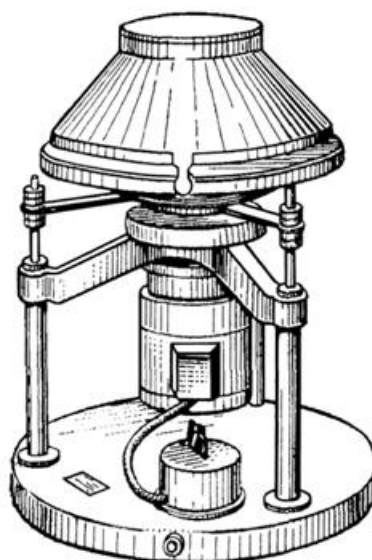


Fig. 8. PVZ device.

If temperature of grain is less than 5 °C, grain warms up to 25 – 30°C during 10 – 20 min for activation pests, which grow numb. Large pests that remains on the sieves manually selected on white glass of special desk and count up them. That to fall on bottom plate strew out on black glass of special desk and count up them with used of magnifying glass or strew out on special black bottom plate of device POOK-1 (fig. 9), switch on light and count up little pests. Quantity of alive pests to count over on 1 kg of grain (tab. 5) for determination degrees of grain infestation by ticks and weevils

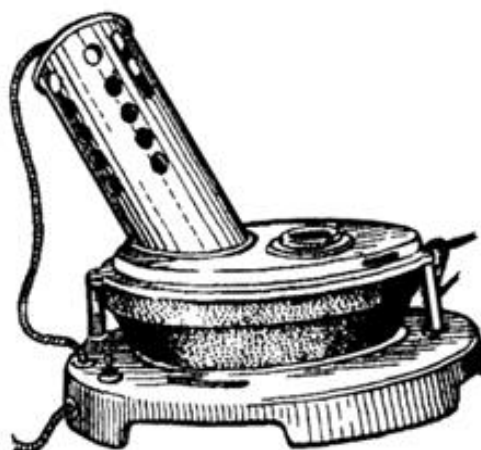


Fig. 9. POOK-1 device.

Determination of pests at the hidden form. Pests are determined with the methods of splitting or colouring “plug”.

Method of splitting. We take 50 g grain of wheat from an average sample, then take 50 undamaged corns and split them over a groove. Alive pests in different stages of development are counted up under a magnifying glass.

Method of colouring “plug”. We take 50 g grains of wheat from an average sample and then take 250 undamaged corns. The grain is dived into warm water

(30 °C) for 1 min., and then dived into 1 % solution of potassium permanganate for 20-30 sec., into cold water for 20-30 sec., then it strewed out on a white paper and infected grain is counted up.

The infected grains are cut and quantity of alive larva, dolls or bugs of weevil are counted up. Quantity of infected grain X (%) is determined using a formula:

$$X = \frac{K_1}{K} \times 100,$$

where K_1 – quantity of infected grain, pieces;

K – quantity of grains selected for the analysis, pieces

Determination of wheat damages by a corn-bug.

We take 2 samples of whole grain with weight is 10 g from average sample and manually selected them according three signs of wheat damage by a corn-bug.

The signs of wheat damage by a corn-bug.

1. The dark point is a prick place of the corn-bug. This point is sharply outlined by light yellow spot of circular or a wrong form;

2. The same as a spot on a surface of grain within it is indent or wrinkle without a dark point in a place of prick;

3. The same as a spot on a surface of grain in a germ without dark point in a place of prick and without indent or wrinkle.

The level of damaged grain by a corn-bug determines using formulas:

$$X_k = M \times 10,$$

where M – weight of damaged grain in every sample, g.

Results are written down, as an average of arithmetic two measurements:

$$X_{k0} = \frac{X_{k1} + X_{k2}}{2},$$

where X_{k1} and X_{k2} – level of damaged grain by corn-bug in the first and the second samples, %.

Questions to the lesson.

1. What are the basic barn pests do you know?
2. What basic barn pests which damage of peas do you know?
3. Degrees of grain infestation by weevil.
4. Degrees of infestation grain by ticks.
5. What is admitted grain infestation by barn pests?
6. What forms of grain infestation by pests do you know?
7. Tell determination of grain infestation by pests in the obvious form.
8. Tell determination of grain infestation by pests in the hidden form.
9. Tell determination of grain infestation by the method of splitting.
10. Tell determination of grain infestation by the method of colouring “plug”.
11. Tell determination of grain damages by a corn-bug.
12. Write down signs damages of wheat grain by a corn-bug.

Lesson 4. Determination of grain-unit by liter corn balance

The requirements of standards to grain-unit for different crops (g/l)

| Crops | Destination | Classes | | | | | |
|-------------|----------------|---------|-----|-----------|-----------|-----------|-----------|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Soft wheat | food grain | 760 | 740 | 730 | 710 | 710 | unlimited |
| Durum wheat | food grain | 750 | 750 | 730 | 710 | unlimited | – |
| Barley | food grain | 600 | - | - | - | - | - |
| Barley | producing malt | - | 570 | unlimited | - | - | - |
| Rye | purveying | 700 | 700 | 690 | unlimited | - | - |
| Oats | purveying | 520 | 520 | 490 | unlimited | - | - |
| Triticale | food grain | 680 | 650 | unlimited | | | |

* – hectoliter – one hundred liters. Symbol: hl.

Meaning, definition of a grain-unit and factors that affect it. Method determination of grain-unit.

Grain-unit is the grain weight of certain volume. The grain-unit expressed by weight of 1 liter of grain in grams or by weight 1 hl* grain in kg for export-import grain. The grain-unit very depends on crops and cultivation conditions.

Factors which influence on a grain-unit - humidity, impurities, the form of grain, temperature, damage by pest. The form of grain and its uniformity influence on a grain-unit because these factors determine accommodation of grain in a corresponding vessel. The second important factor which influences on a grain-unit is density of grain which depends on its biological structure and chemical compounds including contents of moisture. Practice shows, that the worst filled grain and contains more moisture and impurity then it has lowest grain-unit. The impurities are divided into mineral and organic ones. The mineral impurities increase grain-unit but organic impurities reduce it.

Humidity changes grain-unit, because the final result writes down taking into account level humidity. So, if humidity of wheat exceeds basic norm for each percent of humidity over basic norm the final result will increase on 5 g/l for I, II and III types and on 3 g/l — for IV type. If humidity of rye exceeds basic norm for each percent of humidity over basic norm the final result of grain-unit will increase on 5 g/l.

Determination of grain-unit is carrying out after clearing grain at a room temperature by a litter corn balance (fig. 10) according **ГОСТ 10840-64. Зерно. Метод визначення натурі**. Liter corn balance have reception cylinder, measure cylinder, cylinder funnel, special knife and plummet. We take the reception cylinder and put it in a special groove of device. A knife with number to top inserts into a slot of a reception cylinder. Plummet with number to top puts on the knife. Put on the top a cylinder funnel. Pour out grain into the measure cylinder up to top

is 3-4 cm. Then measure cylinder is put on a top. We open the valve.

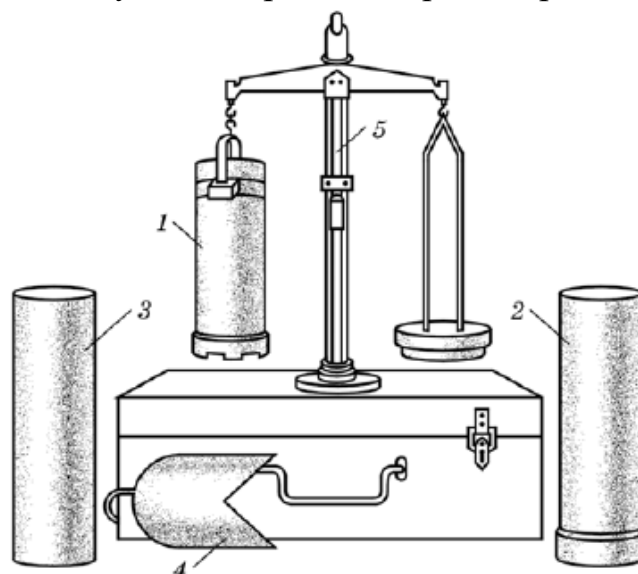


Fig. 10. A liter corn balance for determination of grain-unit of grain: 1 – a reception cylinder; 2 – a cylinder funnel; 3 – a measure cylinder; 4 – a knife

The grain pours out into a cylinder funnel. We take down the measure cylinder. Then draw out a knife slowly. The plummet moves down and pushes out air before itself and involves grain behind itself from the cylinder funnel. We insert a knife into a slot and cut excess of grain. The distance between a plummet and a knife is exactly 1 liter. We take down the cylinder funnel and pour out excess of grain, draw out a knife and weigh the reception cylinder with grain.

The grain-unit from each sample should be determined twice from different portions of grain. The difference of parallel determinations for wheat, barley and rye should not exceed 5 g/l, for an oat - 10 g/l. Precision of determination is 1 g.

Influence of grain-unit on a grain price.

A sharply lowered grain-unit (frost-shattered, damaged by hot wind, damaged by a corn-bug) affects on the discount at a rate. For example, if grain-unit of wheat up to 650 g/l applies the discount from the price is 15 %. If grain-unit of wheat is 600 g/l and smaller the discount will increase up to 30 % from the price.

For everyone 10 g a grain-unit over basic norm applies the extra charge at 0.1 % from the price but for everyone 10 g a grain-unit less than basic norm applies the discount at 0.1 % from the price.

Questions to the lesson.

1. What is a grain-unit? Units of its measurement. Precision of measurement of a grain-unit?
2. Point out crops and destination which grain-unit required by standards?
3. Factors which influence on the grain-unit.
4. How many grains fill up to the measured cylinder before determination of grain-unit?

5. What is the difference of parallel determination of grain-unit in the grain of wheat, barley, rye, oats?

6. If humidity of grain is greater than a base norm how can we count a final result of the grain-unit of wheat and rye?

7. What are extra charges and discounts applied for everyone 10 g of grain-unit when it meaning more and less than a basic norm?

8. What discounts are applied for grain of wheat with sharply lowered grain-unit:

grain-unit of wheat from 600 g/l till 650 g/l?

grain-unit is 600 g/l and less?

Lesson 5. The determination humidity of grain

Norms of standards for grain humidity different crops

| № | Crops | Humidity, % |
|----|---------------------|-------------|
| 1 | Soft wheat | 14.0 |
| 2 | Durum (hard) wheat | 14.5 |
| 3 | Rye | 14.5 |
| 4 | Oat (purveying) | 13.5 |
| 5 | Barley (food grain) | 14.5 |
| 6 | Triticale | 14.5 |
| 7 | Sunflower | 7.0 |
| 8 | Maize | 15.0 |
| 9 | Pea | 15.0 |
| 10 | Buckwheat | 14.5 |

The methods of grain humidity determination.

Humidity of grain is determined by direct and indirect methods and the last methods have advantages. Direct is method of distillation. The basic indirect methods (standard) is drying grain in an air-oven (fig. 11) at temperature 130 °C during 40 min (maize 60 min).

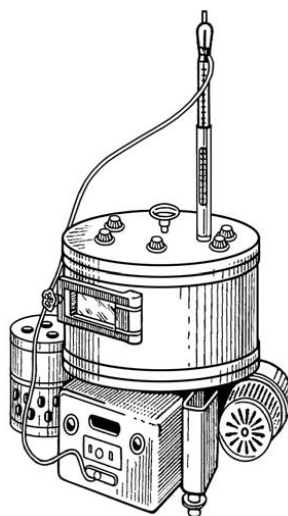


Fig.11. Air-oven for determination humidity of grain

Electrometric methods are additional. They are foundation on properties of grain such as dielectric permeability and electro-conductivity.

Meaning “critical” and “balance” humidity of grain. Subdivide of grain over the humidity.

Critical humidity of grain is the value of humidity when free moisture appears in grain. Balance humidity of grain is the state of grain when it doesn't take and escape humidity.

Subdivision of grain over the humidity, %

| Grain | Dry | Average dryness | Moist | Wet |
|-------------------------------|-----|-----------------|-------|------|
| Wheat, rye, barley, buckwheat | 14 | 15,5 | 17 | 17 |
| Oats | 14 | 16 | 18 | 18 |
| Millet | 13 | 15 | 17 | 17 |
| Maize | 14 | 16 | 18 | 18 |
| Peas, haricot | 16 | 18 | 20 | 20 |
| Sunflower and flax | 11 | 13 | 14,5 | 14,5 |

Drying grain in air-oven may be with preliminary drying (humidity after dry meter more than 17 %) or without preliminary drying (humidity after dry meter less than 17 %).

Determination of humidity without preliminary drying. We take from average sample about 30 g of grains, mill it (degree of milling is 60 %), then take two samples with weight 5 g and place them into metal boxes and put them in air-oven heated up to 130 °C. After 40 min (maize – 60 min) boxes will take out, cool down to the room temperature and weigh to within 0.01. Humidity grain determines using the formula:

$$W = \frac{M_1 - M_2 \times K}{M_1} \times 100,$$

where M_1 – weight of a sample before drying;

M_2 – weight of a sample after drying;

K – correction factor (for grain of millet, rice – 0.1; wheat, rye, barley – 0.3; oats – 0.35; peas, maize – 0.45).

Determination of humidity with preliminary drying. Dry box made from a metal dense grid weigh and fill up by grains (20 ± 0.1 g). The box put into an air-oven heated up to the temperature 110 °C. Then the temperature in air-oven reduces to 105 °C and starts drying. Duration of drying depend on humidity of grain. If humidity of grain is up to 20 % then grain of rye, wheat drying 4 min; oats, millet – 3 min; barley, rice – 5 min; maize, peas – 10 min. At higher humidity duration of drying increases. After drying, grain cools down to the room

temperature and weigh. Further determination of humidity is the same as in a basic method.

Humidity of grain W_1 with preliminary drying determined by a formula:

$$W_1 = 100 \times \left(1 - \frac{M_2 \times M_4}{M_1 \times M_3} \right) + K$$

where M_1, M_2 , – weight of the ground grain before and after drying, g;
 M_3, M_4 - weight of the whole grain before and after drying, g;
 K – correction factor.

Determination humidity of corncob.

Humidity of grain and core of corncob determine separately. Cut off grain from corncob. Then take a sample of grain with the weight of 50 g, mill it and separate two samples of ground grain with weight of 5 g. Humidity of grain determine by a basic method.

Determination humidity of maize core. Maize core is cut off 2 cm from both sides. From the remained part cut off 3 pieces (2 pieces from maize core borders and 1 piece – from a middle part of maize core). Mill it on small pieces and test them using a standard method. Humidity of maize core determine with a formula:

$$W_2 = \frac{M_5 - M_6}{M_5} + K,$$

where M_5 – weight of maize core sample before drying, g;
 M_6 – weight of maize core sample after drying, g;
 K – correction factor (0.1 – if humidity of maize core is less than 15 %; 0.2 – 15-25 %; 0.3 – 25-35 %; 0.5 – 35-45 %).

Humidity of corncob determines correlation between humidity of grain and humidity of maize core. Humidity of total consignment of maize determines correlation between weight of grain to weight of maize core. For example, humidity of grain is 22 %, humidity of maize core is 25 % and correlation between weight of grain to weight of maize core is 76:24 therefore humidity of total consignment of maize is equal:

$$\frac{22 \times 76}{100} + \frac{25 \times 24}{100} = 22.72 \%$$

Questions to the lesson.

1. What methods of grain humidity determination do you know?
2. Determination of grain humidity by a basic method.
3. Additional methods of grain humidity determination.
4. What is critical humidity of grain?
5. What is balance humidity of grain?
6. When determine humidity grain with the basic methods without preliminary drying?
7. When determine humidity grain by the basic methods with preliminary drying?

8. Properties of grain which are used for determination of grain humidity by drymeter.

9. Subdivision of grain depend of quantity of humidity.

Lesson 6. Determination admixtures in grain

Standard norms on content of foreign material, grain admixtures, harmful admixtures for grain difference crops.

Grain mass come on the grain-collection with contains grain of basic crop and also different admixtures. They are divided into 2 groups: foreign materials and grain admixtures. Grain mass depending on quantitative and qualitative structure admixtures has different value and stability to storage. Grain applies to the class of standard depends on the contents of foreign material and grain admixtures.

The structure each admixture in grain of the certain crops normalizes by the corresponding standard. Requirements to the quantity every type of admixtures presented in the Appendixes 7-9.

The fractions of grain admixtures of wheat grain:

- *broken grain* - the parts of grain formed as a result of mechanical action.
- *thin grain* - unfilled grain, wrinkled, slight, deformed as a result of unfavourable conditions of growing and ripening;
- *squeezed grain* - deformed grain, flattened as a result of mechanical action;
- *sprout grain* - grain with rootlets or sprouts which have fallen outside the corn film or sprouts which has broken off the corn film but has not left outside, and grain with lost rootlets and sprouts;
- *frost-shattered grain* - the grain damaged by frosts during ripening, with the changed colour (absent or darkened);
- *damaged grain* - grain with changed of germ from cream up to light brown colour and endosperm owing to self-heating, drying and damages by illnesses;
- *insect bored damage grain* - the grain that have been bored or tunneled by insects will be damaged;
- *unripe grain* - grain which has not reached a full maturity, with a greenish shade, is easily deformed in the case of pressing;
- *whole and damaged grains of rye, triticale and barley* which behind character of damages, according to standards on these crops, do not concern to a foreign material;
- *in 6 class of soft wheat* - grains and seeds of other crops and pulses, which behind character of their damages according to standards on these crops applies to the foreign material.

The fractions of foreign materials of wheat grain:

- *mineral admixtures* - sand, soil, pebble and etc.;
- *organic admixtures* – plants admixtures (parts of stalks, leaves, corn film and etc.), the dead of grain pests, seeds of wild-growing nonpoisonous weeds;
- *harmful admixtures* - plant admixtures which are unhealthy the person and animals;
- *fungus grains* - the grain damage by fungi of a sort Fusarium, absent, sometimes with spots of orange-pink colour, wrinkled, slight, lacking vitality;
- *spoiled grain* - grain with obviously spoiled endosperm from brown up to black colour and grain, which in case of insignificant pressing decompose;
- admixtures which pass through a sieve with a hole of 1 mm;
- spoiled grains of wheat, rye, triticale and barley with obviously spoiled endosperm from brown up to black colour.

- The wheat of Grade 6 - grains and seeds of other cereals and legumes that the nature of injuries, according to the standards for these plants are not referred to as grain foreign material or contaminants.

Structure of the wheat grain:

- *to the basic wheat grains apply:*
 - whole and damaged grains of wheat that the nature of the damage do not apply to the grain admixture and foreign material;
 - small grains - whole wheat, passed through the sieve with holes is 1,7x20 mm;
 - the wheat of 6 class - grains and seeds of other cereals and legumes that the nature of damages, according to the standards for these plants are not applies to as grain admixtures and foreign materials.
- *to the grain admixture of wheat grains apply:*
 - grains of wheat unfilled, sprouted, overheated;
 - grains of wheat with coloured germ: in the durum wheat – all grain, in the soft wheat;
 - broken wheat grains and insect bored damage grain independently of their damages;
 - grains of cereals crops that the nature of their damage, according to the standards for these crops apply to the grain admixtures;
 - in the grain of soft wheat of 4 class – grains and seeds of cereals and leguminous crops that the nature of their damages, according to the standards for these crops apply to the grain admixtures.
- *to the foreign material of wheat grains apply:*
 - pass through a sieve with holes 1.0 mm;
 - mineral, organic and harmful admixture; spoiled grains of wheat, rye, triticale and barley;
 - parts of wheat, rye, triticale and barley with completely eaten endosperm.

To the harmful impurities apply:

smut and ergot (0.05 – 0.1 %); Russian centaury, neale (together) – 0.05 – 0.1 %; coronilla – 0.1 %; a heliotrope – 0.1 %.

Determination total content and fractions of foreign materials and grain admixtures.

Analysis of the average sample starts with determination of large impurity.

Large admixtures. The average sample is weighed and sifts through a sieve with a hole of 6 mm. The remains on sieve are weighed and the results are expressed in % to weight of an average sample. Large admixtures in grain of large-seed crops (maize, peas, haricot and etc.) determine manually selected it from average sample.

The rest of impurities determine after definition and removing large admixture.

Determination foreign materials and grain admixtures.

We take sample of grains to within 0.1 g depend on crops from average sample and sift it through the sieves with a hole of the corresponding diameter (tab. 6). Weight of samples are:

- rye, wheat, buckwheat, barley, an oat, rice, lentil - 50 g;
- maize, peas, haricot, chick-pea - 100 g;
- millet, sorghum - 25 g.

In same samples determine also contents of small grains.

Table 6 – Sieves for determination of foreign materials and grain admixtures

| Crops | Diameter hole of sieves, mm | | |
|------------------------|--|---|------------------------------------|
| | for determination of content small grain | for determination of pass which belong to foreign materials | for determination largest of grain |
| | diameter, mm | | |
| Wheat | 1.7x20 | 1 | |
| Ray | 1.4x20 | 1.0 | - |
| Barley food and fodder | 2.2x20 (for groats barley) | 1.5 | - |
| Barley for brewing | 2.2x20 | 1.5 | 2.5x20 |
| Oat | 1.8x20 (for groats oat) | 1.5 | - |
| Millet | - | 1.4x20 | - |
| Buckwheat | - | 3.0 | diameter 4.0 |
| Rice (grain) | - | 2.0 | - |
| Maize (grain) | diameter 8.0 (I and II type for food concentrates) | 2.5 | - |
| Food haricot | - | 3.0 | - |

The sieves are installed in such a way: on the pan – sieve for selected the pass which belong to foreign materials, further – a sieve for selection of small grains, and then – the sieve for determination largest of grain.

The sample fills up the top sieve and repeats movements along longitudinal slot sift pulses grains during 1 min, other crops - 3 min with intensity 110-112 movements per a min. Remains on sieves are manually selected on the fractions of foreign materials and grain admixtures. Fractions weigh and results will express in percents to weight of corresponding sample.

Content spoiled and damaged grains in the crops wheat, rye, barley, oats, rice, millet and sorghum determine in the sample with weight 10 g. Grain cut across and according to the characteristics set out in corresponding standard, examine them, choose the spoiled, damaged grain and weighed.

Harmful impurity. Content of harmful impurity is determining separately after kinds in additional samples which separate from an average sample after its clearing from large impurity.

If we detect the elements of harmful impurity in samples then their content determines in an additional sample which was cleared from weeds and grain impurities with weight:

20 g at determination of smut grains contents;

200 g - smut in wheat, rye, etc;

500 g - smut in barley;

500 g – ergot grains, hardheads, corn-cockle, coronilla, heliotrope, darnel, stagger bush, trichodesma incanum.

Pebble. Contents of a pebble determine in grain with weight 500 g. Grain clearing from large admixture and sift through the sieve with hole of 1.5 mm. The pebbles that remain on a sieve weigh and result express in % to weight of a sample.

Metal impurity. The content of metal impurity determines in grains sample with weight of 1 kg. Grains strew on the flat surface (thickness of layer is 0.5 cm) and then a horseshoe magnet (load-carrying capacity is 12 kg) is slowly conducting over a layer of grain. Metal impurity which sticks to magnet will weigh and result express in milligrams per 1 kg of grain.

Unfilled grain is defined as the sum of the percentage of grains damaged by frost, unripe (green), small and thin grains.

Smutty grains and *grain damaged by corn-bug* are determined in accordance with GOST 30483.

The general content of foreign material in grain determine as the sum of results of determination in percentage:

– large organic impurity selected on a sieve with the hole of 6 mm; organic impurity selected from a basic sample;

– a large mineral impurity;

– pebbles, seeds of the weed and cultural crops, spoiled grains, a harmful impurity in an additional sample.

The results define the content of impurity put down in documents with accuracy: weed and grain - up to 0.1 %; harmful and separate fractions weed and grain - up to 0.01 %; metal - up to 0.001 %; smut, small grains - up to 0.1 %.

Questions to the lesson.

1. What is size of grain sample for determination admixture in wheat grain?
2. What is size of grain sample for determination admixture in peas and maize grains?
3. What is size of a grain sample for determination admixture in grains of beans?
4. What are holes of sieves for determination admixture in grains of wheat, rye, oat, barley? Time of their sifting.
5. What are holes of sieves for determination admixture in grains of pea? Times sifting for legumes.
6. Write down method determination of grain admixture and foreign materials in wheat grain.
7. Write down method determination of large admixture in wheat grain.
8. What is harmful impurity? Write down method determination of harmful impurities.
9. What fractions of grain admixture of grain do you know?
10. What fractions of foreign materials of grain do you know?
11. What admixtures applies to the organic and mineral?
12. Write down method determination of metal impurity.
13. Write down method determination of pebble.
14. Write down weight of sample for determination admixtures in the crops rye, buckwheat, barley, oat, rice, haricot, millet, sorghum.

Lesson 7. Determination of types and subtypes of grain.

Grain of wheat, rye, maize, millet, peas, rice and some other crops are divided into types. This division is based on different biological, biochemical and physical parameters.

Reception grains on storage, processing carry out only after determination of its typical structure. Division into types and subtypes is based on parameters of a chemical compound and physical properties of grain. Besides, grain of crops is divided into types depend on its special-purpose designation, a botanical kind, a biological form, colour of seed cover, forms of grain and etc.

Typical structure is determined after clearing grains from impurity and also after removal of all spoiled grains. Any way is impossible to use for any purpose to mix of grains certain crop which apply to the different types, and also from different fields even if it is one variety. It will be different on quality.

Determination of typical structure of wheat.

The typical structure of wheat, quantity of hard and soft, white and red wheat is determining manually by sorting out samples with weight 20 g.

The grain of wheat depends on a botanical kind (soft, hard), the biological form (winter, spring) and colour of peels (red, white) divide into 7 types (tab. 7).

Difference characteristic of soft and hard wheat. The top of soft grain wheat opposite to a germ is covered by hair and creates so-called “hairs of brush”. It is visible to the unaided eye. The grain of hard wheat “hairs of brush” is undeveloped (without a magnifying lens it is not visible). Besides, grain of soft and hard wheat differs under the form. Grain of soft wheat is short and roundness, grain of hard wheat is extended and angular-ridge. Colour of soft grain of wheat has 4 shades. Dark coloration testifies to higher content of albumins. Hard wheat has mainly amber-yellow coloration.

Table 7 – Division of wheat on the types according to standard

| Types | The general vitreous, % | The wheat other types, %, more than | |
|------------------------------------|--|--|-----------------------|
| | | total | including |
| I - Soft red spring hard wheat | More than 40 | 10 | 5 of hard |
| II - Soft red winter hard wheat | More than 40 | 10 | 5 of hard |
| III - Soft white spring hard wheat | More than 60 | 10 | Does not take account |
| IV - Soft white winter hard wheat | It is not limited | 10 | Does not take account |
| V - Hard spring wheat | More than 40 | 10 | 10 white |
| VI - Hard winter | More than 40 | 10 | 5 white |
| VII - not classified | Wheat does not correspond to any presented criteria (a mix of types) | | |

Ways separate of soft white and soft red wheat when grain colour is inexpressive.

Colour of grain is determined comparing with the description of this parameter in standards or with the standard for the given grade at bright intensity. The grain with inexpressive colour treats by several ways. The basic way is treatment of grain by 5 %-th solution of caustic sodium (5 g substance dissolves in 100 ml of water). For this purpose, grains with inexpressive colour count up and weigh. Then grains place in a glass and fill up by solution of caustic sodium so that it completely covers grains. After 15 min white wheat will get expressive light-cream coloration and red wheat – red-brown.

If there is no used to treatment grain by solution of alkali, then used boils wheat in water. We take sample with weight 20 g from all grains with inexpressive coloration. Place it in a chemical glass fill up by boiled water so that it completely covers grains and boil it during 20 min. White wheat will have white coloration, and red wheat – brown. After such treatment content of white and red wheat expresses in percentage.

Division of the cereals, groats grain and other crops on types and subtypes respectively to existent standards.

Determination of typical structure of millet.

For determination of typical structure of millet from sample with weight 10 g selected millet of the basic type, impurities and millet other types. The received fractions weigh and the results express in percentage from weight of sample. Millet depends on color peels (white and cream, red, yellow, grey) are divided into 4 types.

Determination of typical structure of rice.

Typical structure of rice establishes by manually assorting sample with weight of 20 g. The received fractions weigh and the results express in percentage from weight of sample. Rice depends on correlation of length to width and consistence of endosperm is divided into 4 types.

| Type | Correlation of length to width | Subtype | Consistence of grain |
|------|--------------------------------|---------|----------------------------|
| I | 3,5 and more | – | Vitreous |
| II | 2,8-3,4 | – | Vitreous |
| III | 2,3-2,7 | 1 2 | Vitreous and semi-vitreous |
| IV | 2,2 and less | 1 2 | Vitreous and semi-vitreous |

Determination of typical structure of peas.

For determination of typical structure of peas take a sample with weight of 100 g, clear it from impurity and spoiled grains. Peas depend on destination are divided into 2 types: food and fodder. Food peas are divided into 2 subtypes (yellow with different shades and green with different shades).

Determination of typical structure of maize. Grain of maize depending on colour and forms of grain is divided into 9 types: I- dentiform yellow; II - dentiform white; III - siliceous yellow; IV- siliceous white; V – semi-dentiform yellow; VI-semi-dentiform white; VII – pop-white; VIII- pop-yellow; IX – wax type.

Determination of typical structure of rye. Grain of rye depends on biological peculiarity and area of cultivation is divided into 3 types: winter-northern, winter-southern and spring rye.

Ways determine vitreous of grain.

Vitreous is a consistence of grain which characterizes its albumin-starching complex. Vitreous is the basic parameter of grain type determination. *Vitreous grain* has greater content of gluten and albumin but *mealy* has greater content of

starch. The vitreous grain receives more flour with high quality. Such type of grain is better to use for baking bread. Mealy grain with high content of starch is better used for the technical purposes (manufacturing malt, glucose and spirit or in the confectionery industry). There are two methods of grain vitreous determination: by diaphanoscope (DSZ-1; DSZ -3) and cutting of grains.

Diaphanoscope method. On a lattice of diaphanoscope placed 100 whole, undamaged grains with groove to bottom, insert it into device and switch on light (fig. 12). Rotate the handle of the device and the analysis of ten grains separately. Vitreous grains are translucent fully, mealy – are not translucent, semi-vitreous – partially. We must investigate two samples for 100 grains every.

General vitreous expresses as sum of completely vitreous grains plus a half of sum semi-vitreous grain.

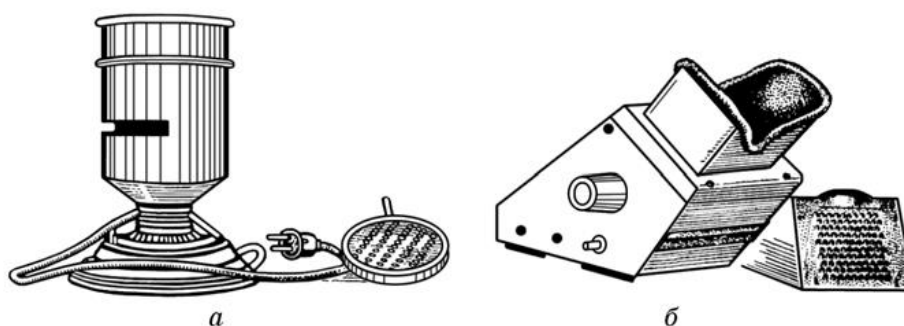


Fig. 12. Diaphanoscopes: a – DZS-1; б – DZS-3

Questions to the lesson.

1. What is vitreous? What is the name of a device for determination of vitreous grain?
2. What is the definition of general vitreous?
3. What is preparation of grain after determination of its type?
4. Weight of a wheat grain sample for determination of its type.
5. What are the basic differences between grain soft and hard wheat?
6. What methods can we use for determining of red and white wheat grain when its colour is inexpressive?
7. Which methods of determination of grain vitreous do you know?
8. How many types of rye grain do you know?
9. How many types of pea's grain do you know?
10. How many types of maize grain do you know?
11. How many types of millet grain do you know?
12. How many types of rice grain do you know?

Lesson 8. Determination of quantity and quality of raw gluten in wheat grain

Norms technological quality of soft and hard wheat grain

Requirements of standard to soft wheat and hard wheat are given in the tab. 8.

Conception of wheat gluten.

Gluten (chemical composition). Gluten of grain is dry gel that is swelled in water and forms a phase of hydrated albumin.

Washed gluten is rubber-like elastic weight remained after washing up the wheaten test by water. There are wet gluten and dry gluten (after drying).

Wet gluten contains about 70 % of water. The dry substances of gluten include gliadine – 39-45 %, glutenine – 34-40 %, globuline and albumine – 3-7 %, fats – 2-9 %, starch – 0.01-9.5 %, sugar – 1-2 % and ash – 0.3-3 %.

Gluten quality (physical indexes). Wet gluten has the important physical properties such as elasticity, extensibility and gas-retaining abilities (viscosity and connected) and also ability to store these properties during washing up. Bread-making quality of grain depends on its properties. Gluten influences on formation of mechanical basis of dough and bread crumb structure.

Table 8 – Requirements of standard to soft and hard wheat
Requirements to the soft wheat

| Index name | Norms for classes | | | |
|--|-------------------|--------|--------|-----------|
| | 1 | 2 | 3 | 4 |
| Mass part of protein, % | 14.0 | 12.5 | 11.0 | Unlimited |
| Mass part of gluten, % | 28.0 | 23.0 | 18.0 | Unlimited |
| Quality of gluten: units of device VDK | 45-100 | 45-100 | 45-100 | Unlimited |

Requirements to the hard wheat

| Index name | Norms for classes | | | | |
|---------------------------------|-------------------|------|------|------|-----------|
| | 1 | 2 | 3 | 4 | 5 |
| Vitreous, %, unless | 70 | 60 | 50 | 40 | Unlim. |
| Mass part of protein, %, unless | 14.0 | 13.0 | 12.0 | 11.0 | Unlimited |

Factors affecting on quantity and quality of gluten. Quality of gluten depends on conditions of grain cultivation. The grain damaged by corn-bug has sprawl gluten; grain frost shattered, germination, damaged with high temperatures (damaged by drying and hot wind) has gluten which is torn to short pieces.

Determination quantity and quality of gluten.

The determination of gluten quantity. From a daily average sample, we take 30-50 g of a grains, clear them from impurity and crush on a laboratory mill so that crushed grain can be sifted through the sieve N067 and remain on the sieve didn't exceed 2 %. Crushed grain is carefully mixed. Two samples crushed grain with weight of 25 g put into two porcelain mortars separately, add 14 ml of water (18-20 °C) with used water meter (fig. 13a) and knead to reception of the

homogeneous dough with using a laboratory kneader (fig. 13b). Dough rolled up in a ball; put it in a cup, close by glass and leave it during 20 min for swelling of albumins. After 20 min dough is washed up from water manually or mechanically (fig. 14).

The completeness of washing up of gluten can be checked by several ways: 1. *Organoleptic* (water after washing of dough is pure (clean) and gluten begins stick to palms); 2. *Iodine test on starch* (inter glass with pure water pressing several drops from gluten and add a drop of solution iodine in potassium iodide. If gluten was not washed up water is coloured to dark blue colour). 3. *The method of weighting* (gluten which begins to stick to palms, is dried by dry hand and weighed on a technical balance to within 0.1 g. Again gluten is washed up during 2-3 min, dried by hand and weighed. The washings up consider completed if the difference between results of weighing does not exceed 0.1 g.

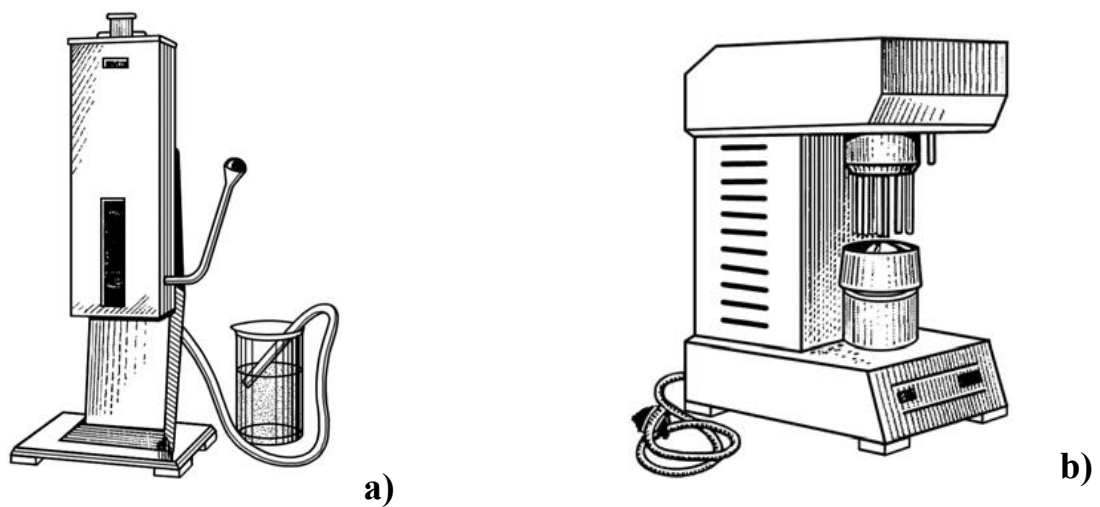


Fig. 13. a) water meter; b) a laboratory kneader

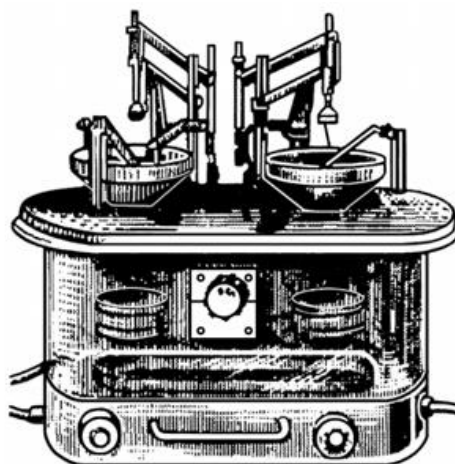


Fig. 14. Device for mechanical washing up of wheat gluten

Dough dry by hands, weigh and its quantity expressing by % multiply result on 4.

The determination quality of gluten. From the washed gluten we take a sample with the weight of 4 g, rumple it 3-4 times by fingers, roll up it to a ball form and put it in a cup with water (temperature of water is 18-20°C) on the 15 min. Then using the device IGD-1 (indicator of gluten deformation) we determine gluten quality in units of IGD (fig. 15). Depend on the units of IGD determine group of quality and characteristic of gluten (tab. 9).

Definitions of “strong” and “valuable” wheat. Valuable wheat is the wheat which can produce bread well and satisfactory quality and has worse indexes of quality than strong wheat. Strong wheat is the wheat which may be improved for flour (content of gluten is more than 28 %, the first group of quality, number of falling is more than 200 s, vitreous is more than or equal 60 %, grain-unit equal or more than norm for the first class).

Table 9 – Characteristic of quality of wheat gluten

| Index of device IGD-1, units | Group of quality | Characteristic of gluten |
|------------------------------|------------------|--------------------------|
| 0-15 | III | unsatisfactorily strong |
| 20-40 | II | well strong |
| 45-75 | I | good |
| 80-100 | II | well weak |
| 105-120 | III | unsatisfactorily weak |

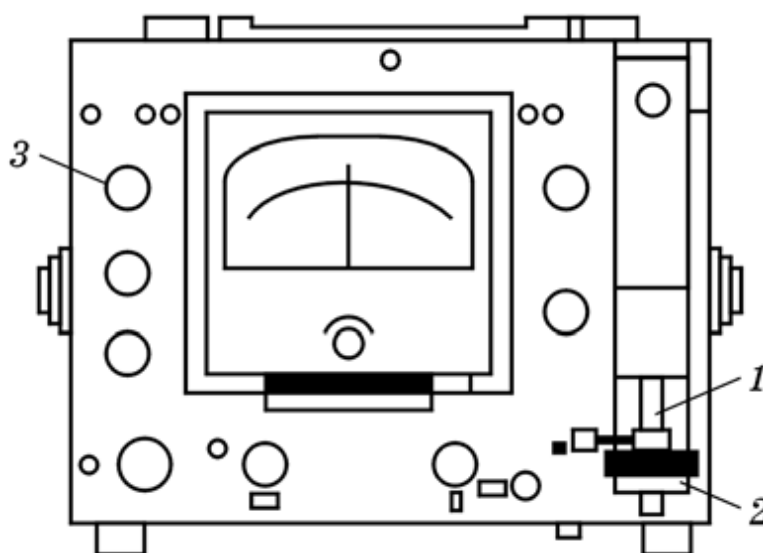


Fig. 15. Device IGD-1

Questions to the lesson.

1. What is gluten? Content of wet gluten.
2. Which physical properties of gluten can be characterized by its quality?

3. Which factors can influence on quantity and quality of gluten?
4. What is valuable wheat? What is strong wheat?
5. Write down method determination of gluten quantity.
6. Write down method determination of gluten quality.
7. What are methods determination finishing washing up of gluten do you know?

Lesson 9. Determination of autolytic activity of grain by "falling number".

Index number of falling. As a result of unfavourable weather conditions during harvesting grain of wheat and rye can be germinating. This enhances amylolytic activity of its enzymes, especially λ – amylase and dramatically worse on the baking properties of flour. Organoleptic determines degree of grain's readiness to sprouting is almost impossible; moreover, changes in grain are not fully understood.

For establish the degree of amylolytic activity of grain enzymes and their influence on baking quality of flour was proposed method of Swedish scientists Hahberh and Perten.

It based on measuring the rate of viscometer plunger dive into paste bumpiness prepared with flour and water. The degree of paste process and dilution of solution depends on the quality grain, enzyme activity and properties of starch. These parameters determine the speed of dive (fall) of viscometer plunger into paste bumpiness. Hence the name of the index is "falling number". The index can range 60 - 400 sec. In unsprouted grain "falling number" is within 180-190 sec, with an average enzyme activity is less than 150 sec., with a high content of sprouted grains is 80 sec or less.

Indicator "falling number" was included in the standards on the grain rye and wheat. "Falling number" in the grain of rye changes depend on the class: I – 200 sec., II – 200 – 141 sec., III – 140 – 80 sec., IV – less than 80 sec.; grain of soft wheat: I – 220 sec., II – 220 sec., III – 180 sec., IV– unlimited; grain of hard wheat: I – 220 sec., II – 200 sec., III – 150 sec., IV– 100 sec., V– unlimited.

Research methods. From the sample of grain, it is necessary to select 300 g, clean it from impurities, grind it with laboratory mills, which have a sieve with holes 0.8 mm and to mix thoroughly. Fill up water bath by distilled water, cover it and set a cooling condenser attached to the tap with cold water. Cooling water should circulate throughout the device during the experiment. At the top of the cover the mixer is put and attached to the cable unit of control timer. Switch on the heater (yellow control lamp lights up) and bring water to the boil. Check the cooling system and the water level; it should rapidly boil throughout the experiment. In a test tube viscometer pour out 25 ml of distilled water with temperature of $22 \pm 2^{\circ}\text{C}$, add 7.00 ± 0.5 g of prepared flour according to its moisture content (tab. 10). In the upper part of the test tube put a rubber stopper; shake the test tube sharply to obtain a homogeneous suspension. Remove the cork and insert plunger into the test-tube and wash the rest of flour which remain on the

walls of the test-tube bottom. Immediately turn the mixer to the working position and from that moment the device works automatically. A plunger works during 60 sec and installers to the top position. Then the viscometer plunger dives into paste bumpiness from the top of the test-tube bottom. After the plunger falls to the bottom of the test-tube a red light switches on and the buzzer activates. The results of research are presented in seconds.

Table 10 – The dependence of the weight of sample flour from the humidity

| Humidity, % | Weight of sample, g | Humidity, % | Weight of sample, g | Humidity, % | Weight of sample, g |
|-------------|---------------------|-------------|---------------------|-------------|---------------------|
| 9,0 | 6,40 | 12,0 | 6,70 | 15,0 | 7,00 |
| 9,2 | 6,45 | 12,2 | 6,70 | 15,2 | 7,00 |
| 9,4 | 6,45 | 12,4 | 6,75 | 15,4 | 7,05 |
| 9,6 | 6,45 | 12,6 | 6,75 | 15,6 | 7,05 |
| 9,8 | 6,50 | 12,8 | 6,80 | 15,8 | 7,10 |
| 10,0 | 6,50 | 13,0 | 6,80 | 16,0 | 7,10 |
| 10,2 | 6,55 | 13,2 | 6,80 | 16,2 | 7,15 |
| 10,4 | 6,55 | 13,4 | 6,85 | 16,4 | 7,15 |
| 10,6 | 6,55 | 13,6 | 6,85 | 16,6 | 7,15 |
| 10,8 | 6,60 | 13,8 | 6,90 | 16,8 | 7,20 |
| 11,0 | 6,60 | 14,0 | 6,90 | 17,0 | 7,20 |
| 11,2 | 6,60 | 14,2 | 6,90 | 17,2 | 7,25 |
| 11,4 | 6,65 | 14,4 | 6,95 | 17,4 | 7,25 |
| 11,6 | 6,65 | 14,6 | 6,95 | 17,6 | 7,30 |
| 11,8 | 6,70 | 14,8 | 7,00 | 17,8 | 7,30 |
| | | | | 18,0 | 7,30 |

Questions to the lesson.

1. What is the falling number?
2. Tell about the method of determining the number of falling.
3. What is size of the flour sample for determination of this index?
4. Indicate level of indexes number of falling for grain of rye and wheat.

Lesson 10. Active aeration of grain mass.

Factions of active aeration. Active aeration may be drying, cooling, heating, ventilation, decontamination grain etc.

Installations for active aeration. For active aeration of grain, the installations are used, which are divided into two groups: stationary and portable ones.

Stationary ventilation installations:

- stationary installations, SVU-1 or SVU-2 type, which have stationary channels in a floor of granary or a barn floor;
- bins (BV-6; BV-12.5; BV-25; BV-50);

Portable ventilation installations:

floor portable has the system of portable air-distributing gridiron which put it in the certain place on floor of granary or a barn floor («Promzemproekt»);

tube mobile:

- mobile one-tube installations (PVU-1);
- telescopic ventilating installations (TVU-2).

Expediency of active aeration. For determination of expediency of grain active ventilation one should know its equilibrium moisture under certain conditions. It is defined using planchettes (Fig. 16) and nomograms. On the planchettes the scales indicate the temperatures after dry and wet thermometers connect their line and draw out it to across scale absolute humidity. On the scale of planchettes indicated actual temperature of grain, connect this point with the point on the scale of absolute humidity line and draw out it to across scale equilibrium humidity of grain. If actual grain humidity is lager, then equilibrium humidity of grain on the 1 % and more ventilation of grain mass is expedient.

Regimes of active aeration. Ventilation is effective when we keep regime of ventilation, which is determined by temperature, humidity, height of grain bulk, the specific air supply and duration of ventilation. One major factor is the specific air supply that is equal to the amount of air (m^3), passing through the grain bulk for 1 h to the quantity of ventilated grain (t) (Tab. 11–13).

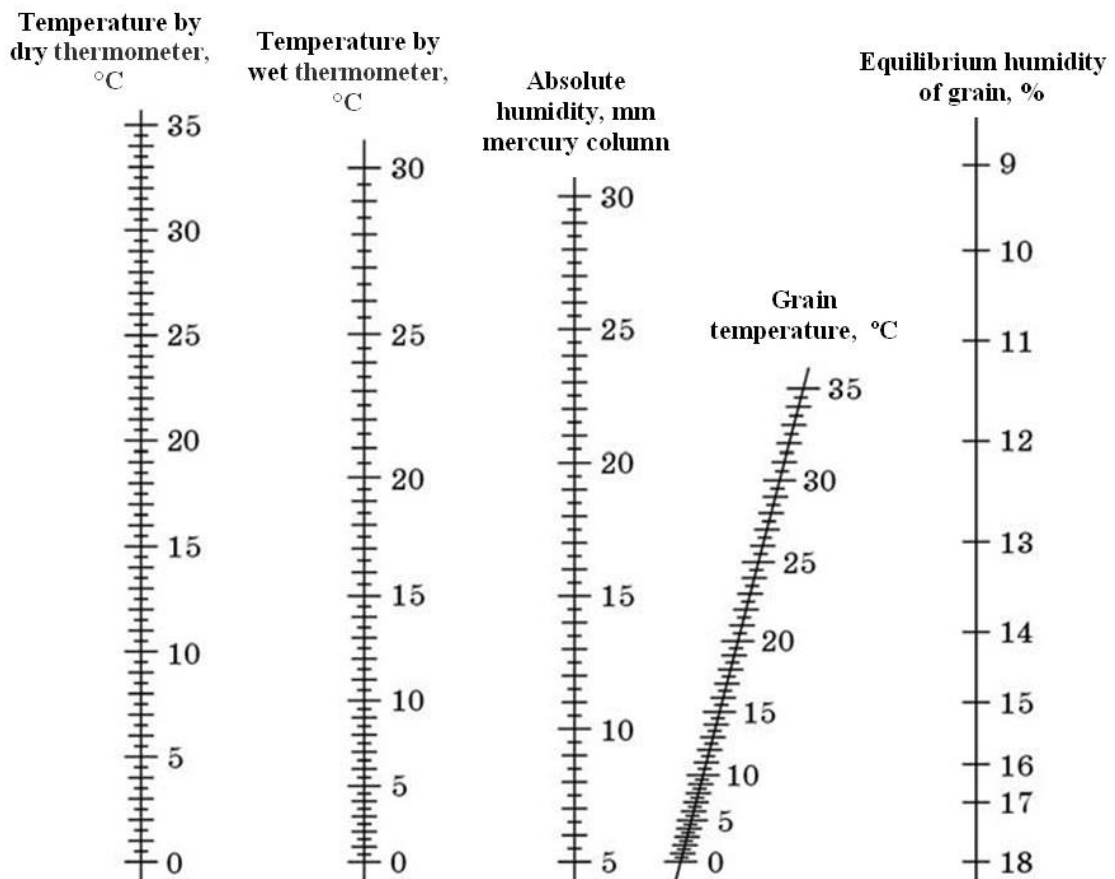


Fig. 16. Planchettes for determine the expediency of grain mass ventilation when the air temperature is above 0°C

Table 11 – The minimum specific of air supply in ventilation grains with different moisture

| Humidity of grain, % | Specific air supply, m ³ /(t •h), at least | Height of grain bulk, m | | | |
|----------------------|---|--|--------------------|--------------|--|
| | | grain of wheat, rye, barley, oats, maize | seeds of sunflower | millet grain | |
| 16 | 30 | 3.5 | 3.7 | 2.0 | |
| 18 | 40 | 2.5 | 2.5 | 2.0 | |
| 20 | 60 | 2.0 | 2.0 | 1.8 | |
| 22 | 80 | 2.0 | 2.0 | 1.6 | |

Table 12 – The rate of drying grain aeration at the atmospheric air during the harvest (for the northern regions Ukraine).

| Initial humidity of grain, % | Reducing humidity, % per day | | | | | | | |
|------------------------------|------------------------------|------------|------------|------------|-----------|------------|------------|------------|
| | the first | | the second | | the third | | the fourth | |
| | total | for 1 hour | total | for 1 hour | total | for 1 hour | total | for 1 hour |
| 22 | 3.6 | 0.15 | 7.6 | 0.168 | 12.2 | 0.169 | 17.4 | 0.181 |
| 21 | 4.0 | 0.167 | 3.6 | 0.179 | 13.8 | 0.192 | 20.0 | 0.208 |
| 20 | 4.8 | 0.192 | 9.8 | 0.204 | 16.0 | 0.222 | 23.2 | 0.242 |
| 19 | 5.2 | 0.217 | 11.4 | 0.238 | 18.6 | 0.258 | 26.8 | 0.279 |
| 18 | 6.2 | 0.258 | 13.4 | 0.279 | 21.3 | 0.300 | – | – |
| 17 | 7.2 | 0.300 | 15.4 | 0.321 | – | – | – | – |
| 16 | 8.2 | 0.342 | – | – | – | – | – | – |

Table 13 – Duration of cooling grain mass by ventilation.

| The difference of temperature between grain and air, °C | The average cooling rate of grain, °C/h, with the volume specific air supply, m ³ /(m•h) | | | | | |
|---|---|------|------|------|-----|------|
| | 20 | 40 | 60 | 80 | 100 | 120 |
| 5 | 0.04 | 0.08 | 0.12 | 0.16 | 0.2 | 0.24 |
| 10 | 0.05 | 0.16 | 0.24 | 0.32 | 0.4 | 0.48 |
| 15 | 0.12 | 0.24 | 0.36 | 0.48 | 0.6 | 0.72 |
| 20 | 0.16 | 0.32 | 0.48 | 0.64 | 0.8 | 0.96 |
| 25 | 0.20 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 |

Questions to the lesson.

1. What is active aeration of grain mass?
2. Which factions of active aeration do you know?
3. How to determine the expediency of active aeration?
4. What is specific air supply?

Lesson 11. Technological calculation clearing of grain

Grain cleaning. Cleaning operations leave all kinds of impurities mixed with the grain; they comprise both vegetable (e.g. foreign seeds or kernels, chaff, stalk, empty grains, etc.) and mineral materials (e.g. earth, stones, sand, metal particles, etc.), and can adversely affect subsequent storage and processing conditions. The cleaning operation aims at removing as much trash as possible from the threshed grain. The simplest traditional cleaning method is winnowing, which uses the wind to remove light elements from the grain.

Mechanized cleaning. The most rustic equipment is the winnower a fanoriginated current of air passes through several superposed reciprocating sieves or screens. This type of machine was widely used in the past for on-farm cleaning of seed in Europe. It can be either manually powered or motorised; capacities range from a few hundred kilograms to several tonnes per hour.

In Europe, with the use of combine harvesters and the development of centralized gathering, cereal winnowers have been progressively replaced by seed cleaners in the big storage centres. These machines, also equipped with a system of vibrating sieves, are generally capable of very high outputs (several tens of tonnes per hour). In developing countries, mechanizing the cleaning operation at village level has seldom been felt as a necessity, because of the lack of quality standards in grain trading. However, because of the current trend towards privatization of marketing networks, the demand for cleaning machines will probably increase. The local manufacture and popularization of simple and easily portable equipment, such as winnowers or screen graders suited to cereal crops, need to be encouraged.

Ways of clarification and sorting of grain.

Separation in a stream of air is based on distinction of impurity and seeds behind specific weight. Separation on sieves is based on a difference of impurity and grains behind thickness and width. Separation on assorting engines is based on the difference between of impurity and grains behind length (corncockle and wild oat. Separation on hills is based on a difference of impurity and grains behind properties of surface and its form. Separation grain on electromagnetic plants. Grain pour out in cylinders with a metal powder (1 - 2 % from grain weight), which stick to seeds of weeds. For separate of grain mass on fractions used different physico-mechanical properties of grain and impurity. For example, shape of surface, state of a surface, specific weight, aerodynamic properties, differences in sizes, kinds of cleaning of grain.

Depend on from grain humidity and content of impurity distinction technologies of cleaning: 1. primary cleaning (humidity 18-40 %, impurity 10-20 %. Remove unless 50 % impurity); 2. the first cleaning (humidity don't more 18 % and impurity to 8 %); 3. the second cleaning (clarification of grain from hardseparation impurity).

Depend on from technologies of cleaning distinction the types of clarifier machines:

1. machines of primary treatment (bread grain), 2. machines for a seed grain;
3. special machines for clarification of grain from hardseparation impurity.

The first type applies to primary treatment of a bread grain. The second and third types of machines are destined for clarification and sorting of seed grain.

Kinds of grain cleaning. The primary cleaning (humidity 18-40 %, admixtures 10-20 %. Remove unless 50 % admixtures). The first cleaning (humidity up to 18 % and admixtures up to 8 %). The second cleaning (clarification of grain from hardseparation admixtures).

Clarifier machines are divided into behind a structure of working bodies:

- air (unsieves);
- air-sieves;
- assorting engines;
- air-sieves-assorting engines.

Questions to the lesson.

1. What are ways of the grain clarification and sorting do you know?
2. Write down types of clarifier machines.
3. Write down kinds of grain cleaning.
4. Indicate factors which influence on the decreasing productivity clarifying machine.

Lesson 12. Technological calculation drying of grain

Drying of grain.

Drying is a basis technological operation for carrying out grain and seeds to constant state. Ways of drying are warm (include vacuum drying), sorption (contact) and mechanical (centrifugation). Warm drying to divide into without special give off warm (air-solar) and with special give off warm (contact and convection). Contact drying is warmth transferred through a hard surface but convection warmth is transferred by air. Basic method of grain drying is convection with used special installation (grain dryers).

Temperature of grain heating depends on:

- cultures (wheat, barley - up to 50 °C, wheat with weak gluten 50-55 °C, a rye – 60 °C, pulses - 36-38 °C);
- purpose (grain which use for processing malt – do not more 40 °C, seed grain do not more 45 °C);
- initial humidity (than the more humidity - that the lowest temperature of heating). Seeds with high humidity (over 22 %) pass through dryers twice, and even three times. If humidity of seeds about 17 % it will do one passing.

Basic types of grain dryers in a Ukraine are:

- chamber drier;
- mine drier;
- drum-type drier;
- recycling drier.

Questions to the lesson.

1. Indicate ways of the grain drying.
2. Write down factors which influence on the temperature grain heating at drying?
3. Which basic types of grain dryers in a Ukraine do you know?
4. How is calculate volume of works for grain drying in the plan units?
5. How is calculate actual productivity of grain dryer?

Lesson 13. Grain payments depending on its quality

Payment for grain on grain-collection enterprise.

Acceptance of grain, oilseeds and herbs at grain-collection enterprise begins with the organoleptic evaluation of the consignment that has come. If obvious differences in grain quality requirements of the standard were not detected, then laboratory assistant would begin sampling. After the formation of the final sampling test check organoleptic evaluation, then determine infestation by barn pests, determine the grain humidity for the location and selection of samples from a combined sample for preparation of average daily sample of homogeneous consignment. According to this sample at the end of the day we define all the other indicators of grain quality, including humidity by the main method. Results from analysis of average daily samples are recorded in the laboratory magazine and then transfer to the register of consignment and receipt checks. Average daily sample is stored during the day. If the deliver does not agree with the assessment of quality of the grain provided at the certain elevator point, during the overnight sample will be sent to arbitration laboratory or provide re-analysis with the presence of the inspector of this laboratory. Quality of grass seeds specifies the control - seed laboratory.

With the carriage of grain, cereals, barley malt, soft and durum wheat, seeds of every culture, the economy in advance present acts of field testing of crops from which these products got and at the day of delivery, except for inventory consignment notes, wrote out one of the following documents: certificate of certified seed – for the seed of first and subsequent reproductions, which does not meet standard of cleanliness and humidity; certificate for seed, if it meets the standard, certificate of elite seeds and super elite of all crops and self-pollination lines of maize seeds. Allowance by class is paid for the seed of first and second categories of grade purity.

For strong seed and durum wheat, malt barley and other varieties of crops the higher prices are used.

When the receipts of heterogeneous grain quality are determined to do the analysis for one sample is not allowed. The number of average daily samples selected as long as the quality of consignment came, though one culture, one owner even a botanical variety.

At the basis of the price of a particular grain products are the basic rules of quality as standard according to the respective seed culture. On these norms the calculations for sold grain and seeds by farms in the light variations are provided.

The grain of strong and durum wheat is accepted by class documents. List of strong classes of wheat, malt barley and classes of other crops annually reviewed and approved by the competent authorities of the agricultural complex.

Increased prices for grain used for the grain of food destination, which conforms by the quality to the grain of child or dietary nutrition.

On the presence of strong and durum wheat crops, as well as varieties of crops and high-oil sunflower classes the procurement item reported in early summer. Agronomists of procurement points inspect such harvesting crops, look to the documents directly on the farm.

Method of grain payment.

1. Define a class of the soft grain with actual indicators of quality (excepting indicators of humidity and foreign material) and price per 1 ton depending on class.

| Class according to standard | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------------------|------|------|------|------|------|------|
| Price for 1ton, UAH | 7000 | 6800 | 6750 | 6730 | 6720 | 6700 |

2. Define an acceptable weight (per each 1 % of the excess in moisture or foreign material is discount is 1 %). To fit physical weight is reduced to the amount of discounts.

3. Determine the value of acceptable weight (by multiplying acceptable weight on the price per 1 ton).

4. Calculated of drying and cleaning payments of grain:

payment for drying = (physical weight) x (percentage of excess of humidity) = t% x (pay in UAH for every t% decrease of humidity depending on culture);

payment for cleaning = (physical weight) x (percentage of excess of foreign material) = t% x (pay in UAH for every t% decrease of foreign material depending on culture).

For each t % of excess of humidity, payment is 80 UAH.

For each t% of excess of foreign material, payment is 40 UAH.

5. Price discounts and extra charge are determined:

- For every 10 g of grain-unit of grain over basic norms according to class allowance is 0.1 % of extra charge and 10 g for every grain-unit of grain less basic applies the discount is 0.1 %;

- If the grain-unit of wheat grain 650-600 g /l the discount is 15 %, if grain-unit of wheat grain less than 600 grams per liter then discount is 30 % (in case of such low value of grain-unit the payments don't take place for the previous paragraph);

- For each 1 % of the excess of grain admixture apply discount 0.1 %;

- For the infestation by ticks of I and II degree apply discount 0.5 %.

All discounts and extra charge are calculated from the value of acceptable weight.

6. Actual cost of 1 t = ((cost of acceptable weight ± (all price discounts and extra charge) - (payment for drying if it present) – (payment for cleaning if it present)) / (physical weight)).

Questions to the lesson.

1. Which indexes quality of grain influence on the acceptable weight of consignment?
2. How calculate payment for drying and payment for cleaning.
3. Indicate discounts and extra charge which apply for grain selling.
4. How calculate actual cost of the grain consignment?

Lesson 14. Quantitative-qualitative grain accounting during its storage

Arrangement of documents during the acceptance of grain is provided by its quantity in his physical weight with appropriate to one kilogram and quality of the owner. A particular attention should be noted to the accurate determination of humidity content and foreign material at all stages from acceptance of grain to its release, grain products and waste. The manager of enterprise provides a systematic review of weight enterprises by management authorities. Manufacturing Technology Laboratory (MTL) determines the quality of grain according to the established regulations.

In case of detection of facts of differences in index weight more than 0.1% in the weighing of grain the act is issued with the person responsible for delivering cargo. When the owner of grain or financially responsible person of grain warehouse disagree with data of quality analysis conducted by MTL:

-In their presence the re-analysis should be made;

-When you disagree with the data of re-analysis of such grains the sample of grain in day is sent for analysis to laboratories established by State Control of Agricultural Production or transmitted for analysis to the authorized employee of State Control of Agricultural Production if it is in the factory;

-The results of analysis were performed by State Control of Agricultural Production is final (Technical regulations of grain composition, Adopted by the Ministry of Agrarian Policy of Ukraine on 15.06.2004, №228).

The owner of grain may deliver grain to the grain warehouse homogeneous and heterogeneous by quality consignments of grain.

Grain of homogeneous consignment is formed in the owner and at the grain warehouse is placed on types, subtypes, as indicators of quality that characterize the technological properties of grain under existing regulations, as well as by indicators of humidity content and foreign material.

Grain heterogeneous consignment - that have different technological properties or accepted with special features: sprouted grains (more than 5 %), frost-shattered, damaged by corn bug, smut grain, fuzarious grain with unusual smell, the presence of difficult separated impurities, pesticides above the permissible limits, etc.

Analysis of aggregate indicators that characterize quality of grain, show the impact of humidity and foreign material content to the mass balance. Other indicators - biological and botanical (type, subtype), chemical (protein, starch, fat, etc.), technological (size and shape of grains or seeds, vitreous, and fulfilled grain, straightness of grain, nature of grain, quantity and quality of gluten, falling number, contents of kernel of cereal crops and other), organoleptic (taste, smell, colour) to change of the balance mass with refining and storage of grain are not affected. This allows us to apply for both homogeneous and heterogeneous consignment law of conservation of weight balance.

Notes in the book of form number 36 (Book of quantitative and qualitative accounting of bakeries) are conducted daily but no later than the day following to the operational period. To this form we write a weight of grain and its quality indicators (humidity content and foreign material). In the graphs 9 and 13 of form number 36 are indicated in ton- percentage humidity, and in graphs 10 and 14 - ton- percentage by foreign material (weight multiplied by % of humidity and foreign material).

Ton-percentage is written in whole units, the share of less than 0.5 - are discarded, and 0.5 and more - are taken per unit. Indicators of humidity and foreign material are written in the books of form number 36 with exactitude to 0.1 %.

Average quality by humidity and foreign material for a period of time are determined by dividing the amount of ton-percentage to the weight of grain or products listed in the column 8 or 12 of form number 36 for the same period.

Average quality is determined with exactitude to 0.01 %.

Physiological characteristics of grain - breathing, post-harvesting ripening have little impact on the carrying balance weight and easy to calculate by the natural losses during the grain realize to owner. For the calculation of natural losses, at first we determine the average time of storage of grain by dividing of amount monthly remains of grain to the receipt of grain. Further, knowing the average time and way to storage of grain (bulk, in containers, etc.) define the norms of natural losses by a table and insert them in the appropriate formula to determine the natural loss during storage period.

At the average term of grain storage up to 3 mounts then norm of losses calculates by formula:

$$X = \frac{a \times b}{90} ,$$

where X – lost of the grain weigh, %;

a – rate of losses up to 3 months included, (according tabl. Appendix 2), %;

b – average quantity days of storage, days;

90 – the whole period of storage, days.

If an average term of grain storage consignment products over 3 months' rate of losses are calculated by the formula:

$$X = M + \frac{L \times K}{N}$$

where X - rate of losses, %;

M - rate of losses for the previous period of storage, according to table (Appendix 2), %;

L - difference between the highest and lowest norms of losses for the intermediate term storage, %;

K – the difference between the average time of storage the consignment and time of storage determination for previous norms, months;

N - the difference between the quantity of months of storage that apply to difference between the losses norms.

During the transporting bread products by rail or water transport natural losses of grain should not exceeded to the control limit rules: at the distance of transportation up to 1000 km - 0,1%; from 1000 till 2000 km - 0.15 %; over 2000 km – 0.2 % and during transportation by car transport control limit rules are: bulk cargo - 0.09 %, freight container - 0.07%.

Questions to the lesson.

1. Indicate factors which influence on the lost of the grain weigh during its storage.
2. Write down formula determination lost of the grain weigh if the average term of grain storage is up to 3 mounts.
3. Write down formula determination lost of the grain weigh if the average term of grain storage is more than 3 mounts.
4. Write down formula determination average term of grain storage.

Lesson 15. Dislocation grains in the granary at the storage

Locating a granary.

The approximate location of a proposed warehouse for grain storage will have been decided already. However, the determination of its exact sitting is a matter for engineers. If a large warehouse is planned, it is always prudent to involve local Civil Engineers at this stage.

Several factors need to be considered in selecting a suitable site. In the first instance the topography of the area has to be studied. It is preferable to erect the warehouse on level ground, ideally slightly raised above the surrounding area, which is well drained and not prone to flooding. Low locations must be avoided. If it is difficult to find a level area then the least undulating or sloping area should be selected, and the site should be oriented along contour lines, in order to minimise the amount of levelling and filling in to be done.

It is then important to determine the characteristics of the soil: its load-bearing capacity, resistance to compaction, and drainage characteristics. Never build on black cotton soils, because these are weak and do not have sufficient soil-bearing capacity even for small warehouses. The warehouse and the approaches to it will need to be protected from running water by an effective drainage system, and the site should be able to accommodate such a system.

For easy access and movement of stocks, the warehouse should be sited as near as possible to a main road. It is also important to ensure that the approaches to the warehouse will permit easy movement and manoeuvring of vehicles around it.

This means that, in addition to the area to be occupied by the warehouse, there should be plenty of usable space around it. Also, looking to the future, there should be sufficient space for the erection of additional warehouses and utility buildings.

In tropical countries it is very important that the long axes of warehouses are oriented East-West as nearly as possible. This way, the side walls are least exposed to the sun and temperature variations inside are minimised. If the warehouse cannot be oriented East-West, some benefit may be derived from sitting it across the direction of the prevailing wind. The interior can then be effectively cooled by opening all doors and windows at appropriate times.

Finally, bearing in mind that grain in the warehouse will probably be fumigated with gas lethal to human beings from time to time, it is important that the site chosen must be a safe distance from dwelling houses, shopping centres and other working areas.

Principal's grain dislocation in the granary.

Consignment of grain in the granary dislocation with taking into account:

1. their purpose (food, fodder, sowing material);
2. humidity, presence of admixtures, signs infection by barn pests, diseases and on the features which are taken into account separately (for example, damage by a corn-bug and etc.;
3. presence of quarantine weeds and etc.).

Indexes grain quality which testing during its storage.

- temperature of grain mass and in the granary;
- grain moisture and in the granary;
- infection of grain by barn pests;
- indicators of freshness (colour and smell).

Additional (in consignment of seed grain) check:

- germinating ability;
- germinating power;
- viability.

Questions to the lesson.

1. Indicate principal's dislocation grains in the granary.
2. Which indexes quality of the bread grain testing during its storage?
3. Which indexes quality of the seed grain testing during its storage?
4. Write down basic principles granaries dislocation?

Lesson 16. Estimation quality of the groats grain

Quality of groats is determined by its chemical content, technological and consumer properties. Technological properties of groats grain are divided into three groups:

- parameters of the general grain condition;
- parameters of the groats properties;
- consumer properties of groats.

Parameters of the general grain condition. These indexes, which characterize general grain condition are established by the quality of grain for processing at general indication suitability for its production of groats. There are indexes:

- colour and smell is characteristic for normal, healthy condition of grain;
- content of impurity (from 1 % to 3 % in buckwheat and millet) and grain impurity (from 2 % in rice and barley to 6 % in millet);
- humidity of grain (from 14.5 % in barley and 16 % in buckwheat).

Parameters of the groats properties;

- content of kernel in corn (buckwheat – more than 71 %, millet – 74 %, groats oat – 60 %; for other plants it is index do not used);
- paleaceous;
- uniformity (depend types and sorts);
- coarseness;
- consistence of endosperm – vitreous (only grain wheat and rice).

Paleaceous is a parameter which it is possible to determine the contents of a kernel in grain and a probable output of groats. *Uniformity* is one of the most important index quality of groats grain. Grains of different types and sorts have different structurally-mechanical properties.

Consumer properties of groats. Groats are estimate after cooking by quality of porridge according indexes:

- organoleptic (colour, smell, taste);
- structure;
- duration of cooking;
- coefficient boil soft (ratio volume groats after cooking to volume groats before cooking);
- consistence of porridge (friable, viscous).

The requirements of standards to the quality of groats grain different crops.

Buckwheat depend on quality divided into three grades

| Indexes | Grade | | |
|-----------------------------------|-------|------|------|
| | 1 | 2 | 3 |
| Humidity, %, do not more | 14.5 | 14.5 | 14.5 |
| Grain admixture, %, do not more | 2.0 | 3.0 | 5.0 |
| Foreign materials, %, do not more | 2.0 | 2.5 | 3.0 |
| Content of kernel, %, do not less | 73.0 | 71.0 | 69.0 |

The requirements to the grain of oats:

- moisture content – up to 13.5%;
- foreign materials – up to 1.0%;
- grain admixtures – up to 2.0%;
- content of kernel, do not less – 60%.

The requirements to the grain of millet:

- moisture content – up to 13.0%;
- foreign materials – up to 1.0%;
- grain admixtures – up to 1.0%;
- content of kernel, do not less – 74%.

The requirements to the grain of rice:

- moisture content – up to 14.0%;
- foreign materials – up to 1.0%;
- grain admixtures – up to 2.0%.

Norms output of groats for grain of the different crops: rice – 65%, buckwheat – 67 %, oats – 44-45 %, barley – 40 %, pearl barley and peeled barley - 62, peas whole and split peas - 73, maize groats – 40%.

The requirements to quality of millet grain

| Indexes quality | Grade norms | | |
|-------------------------------------|---|------|------|
| | High | I | II |
| Color | Yellow different shades | | |
| Taste | The peculiar to millet, without foreign flavors, do not sour, do not bitter | | |
| Smell | The peculiar to millet, without foreign smells, do not musty, do not moldy | | |
| Humidity, %, does not more | 14 | 14 | 14 |
| Kernel of good quality, % | 99.2 | 98.7 | 98.0 |
| Mineral admixture, % | 0.05 | 0.05 | 0.05 |
| Harmful admixture, %, does not more | 0.05 | 0.05 | 0.05 |
| Damaged kernel, %, does not more | 0.4 | 0.6 | 0.8 |
| Infection by barn pest, grade | Do not admitted | | |
| Unpeeled grain, %, does not more | 0.3 | 0.4 | 0.6 |

Method determination paleaceous in the cereals and pulses crops

Than the lower content of peels in the grain then groats output is higher. But the peel of grain is not strong therefore it quickly damaged and quickly spoiled.

The highest peels content is in oats grain (up to 45%); Valuable varieties of oats are considered with content of peels up to 22%.

Small grains, grain admixture and foreign materials removed before determination the paleaceous of grain.

Paleaceous determine with using devices or manually. Peels content some crops (**millet, buckwheat and rice**) may be established by manually or by special peelers. Paleaceous grains of **oat, pea and barley** determines only by manually.

Researches.

We take two parallel samples for analysis (rice – 10 g, millet, buckwheat, oat – 5 g, barley – 50 seeds, pea – 25 seeds).

Peels from grain of buckwheat take off by manually; oats grain – pressing the kernel by manually; grains of millet and rice – by manually.

The paleaceous of rice grains is determined by the laboratory peeler "Satake", millet – by ГДФ (Fig. 7) and buckwheat – by БИГ-1.

Quantity of peels expressed in the percentages. Difference between two results should not exceed 1%.

As a result of the analysis take the arithmetic mean of two parallel determinations with an accuracy of 0.1%.

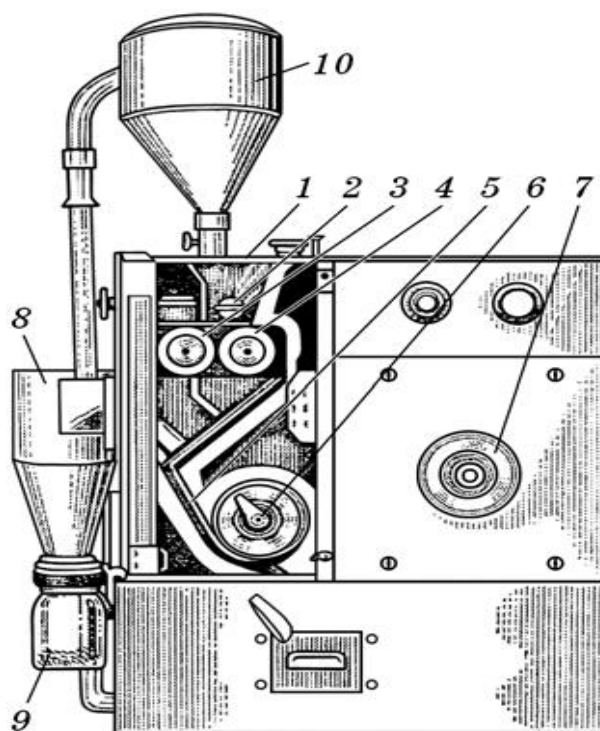


Fig. 7. The laboratory peeler ГДФ-1М:

1 – frame; 2 – feed roller; 3 – high-speed rubber roller; 4 – slow-speed rubber roller; 5 – pneumatic channel; 6 – fan to remove of peels; 7 – fan for feed of grain; 8 – cyclone; 9 – tank of peels; 10 – boot chamber

Questions to the lesson.

1. Write down standard norms index quality content of kernel in the grains of the groats crops.
2. What is grain paleaceous?

3. Indicate weight of sample for determination paleaceous in the grains of oat, barley, millet, buckwheat and rice.
4. Write down norms output of groats for grain of the different crops.
5. Point out the requirements of standards to the quality of groats grain different crops.

Lesson 17. Determination output and quality of the wheat flour

Preparation of the grinding mixes. Wheat grain has different flour-grinding properties because it needs preparation before grinding process. Such preparation includes the location grain in granary of mill, separated handling every consignment and creation prescription of the grinding mixes.

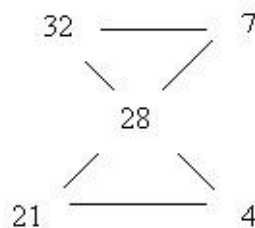
Grain locate depend on type, vitreous, quantity and quality of gluten and in the within type depend on humidity, content of admixtures and etc.

Prescription of grinding mixes created with taking into account their humidity, ash content, type, quantity of gluten, vitreous of grain and etc.

Calculation grinding mixes with depend on quantity of wet gluten (or vitreous) by graphical method.

Example. Prepare a grinding mixture of wheat grain with a total content of raw gluten is 28% on the bases two consignment of grain with a gluten content of 32% and 21%.

Draw out two intersecting lines to the paper. Write down in the intersection place content of raw gluten in the mixture (28). The actual content of gluten in the grain consignment locates to the left. Determine the difference between the actual and the specified content of gluten and write down the results on the right. Combining the results of the calculations with the initial values, we establish that grain with a content of gluten 32% need to take 7 parts, and with a content of gluten 21% – 4 parts. Together is 11 parts.



If we want obtain 500 t grinding mixes of wheat grain with general content of raw gluten 28% from two consignments with content of raw gluten 32 % and 21 % need:

Calculate how many grain include 1 part – $500/11=45.5$ t.

Therefore 7 parts of grain with content 32 % of raw gluten in the grinding mixture will be – $45.5 \times 7=318$ t but quantity of grain with content of raw gluten 21 % will be $500 - 318 = 182$ t.

Standard norms to the quality of flour different crops.

ДСТУ 46.004-99 Борошно пшеничне. Технічні умови. In the Ukraine according this standard produces 4 grades of wheat flour – high, first, second, and ground.

Colour of flour changes depend on the grade from white to white with different shades: white with cream, white with yellow, white with grey. Smell is characteristic for wheat flour without foreign smells. Taste is characteristic for wheat flour without foreign flavours, do not sour and do not bitter. Mineral impurities – as a result flour crushing is do not a crunch. Humidity is up to 15%. Ash content is depending on the grade from 0.6 till 2.0 %. The quantity of gluten – do not less than 20% for ground flour. Metal-magnetic impurities are up to 3 mg/kg. Infestation by barn pests is not admitted.

ДСТУ 8791:2018. Борошно житнє хлібопекарське. Технічні умови. In the Ukraine according this standard produces 3 grades of rye flour – pearl, sifted, ground.

Smell is characteristic for rye flour without foreign smells. Taste is characteristic for rye flour without foreign flavours, do not sour and do not bitter. Mineral impurities – as a result flour crushing is do not a crunch. Number of falling is doing not less 160 sec. in the sifted flour, 150 sec. – in the pearl and 105 sec. –in the ground. Humidity is up to 15%. Metal-magnetic impurities are up to 3 mg/kg. Infestation by barn pests is not admitted.

Methods colour, smell, taste and crunch of flour determination.

The smell, taste and crunch are determined according to the characteristics specified in the standards for flour.

According to the standard smell of wheat flour must be characteristic to wheat, without foreign smells, without musty, without mouldy.

Determine colour of flour. Colour of the flour determine at the daylight or bright enough light, comparing the investigated samples of flour with a sample of flour of a certain grade. On a clean glass 50x150 mm, pour 5-10 g of the investigated samples of flour and the same standard sample. A smooth scoop or a glass is planning both portions of flour so that the layer is 5 mm thick. The investigated flour should come in contact with the standard sample. The surface of the flour is pressed by a glass plate, and the plate's makes the sample in the form of a rectangle. These rectangles are compared with each other.

Determine colour of flour by wet sample. The plate with compressed samples of flour, carefully, in an inclined position (30-45°), dive into a vessel with water at room temperature; in the absence appearing of bubbles of air, the plate with samples is taken out of the water. Keep the plate in a tilted position until stream excess of water. Then determine the colour of the flour. For high grade of wheat flour, the colour must be white or white with a creamy shade, the first grade - white or white with a yellowish shade, the second grade - white with a yellowish or grey shade.

Determine smell of flour. From average sample we take sample of flour with weight 20 g pour out on clear paper, warm it by breath and test it smell. For

intensify smell pour out flour in the glass, cover by water with temperature 60 °C and leave it on 2-3 min. Then water pours out and investigates smell of sample.

Determine taste and crunch of flour. Taste and the presence of crunch are determined by chewing 1-2 sample of flour with weight about 1 g.

Taste for wheat flour should be peculiar to flour, without foreign flavours, do not sour and do not bitter.

As a result, crisp of flour should not feel crunch.

In the difference of opinion, the smell, taste and the presence of crunch in the flour are determined by tasting baked bread from this flour.

Determine infestation of flour by barn pests.

There are widespread pests of flour ticks, small and large flour beetles, flour moth. Infection of flour by barn pests according standards is not admitted. Infection is detected in the presence of a smell (sharp, honey), a change in colour (it becomes dirty grey) at the initial inspection of the sample and also at the presents pests, cobwebs, peels of pest and their excrements. If by these signs pests are not found than carry out a more detailed analysis.

We take grain sample with weigh 1 kg from the average sample and sift through the sieve № 056 (wire-net with holes is 0.56 mm) manually during one minute with intensity 120 circular movements per min.

Rest on the sieve pour out white glass of the analysing board and manually test sample by spatula. Select alive and dead pests (larvae, pupae, adults)

A pass through a sieve is used to detect ticks. We pick up by scoop from different places 5 samples with weight 20 g of each.

Samples individually placed on a black glass of the analysing board, aligned and lightly pressed with a sheet of paper or glass to obtain an equal surface with thick 1-2 mm. After 1 min, removing paper or glass and detail testing surface of the flour. Blisters or grooves that appear on the surface of the flour are observed with a magnify glass to establish the presence of live mites.

The temperature of the analytical sample must be not less than 18 °C.

Determine coarseness of grinding.

Flour is a mixture of particles with size from 0.01 till 0.7 mm. The lower grades of flour have greater difference in the size of the particles. The size of particles is very important for baking. Very fine flour is poorly wet, as a result distribution of yeast to make worse and the quality of gluten is reduced due to damage to protein micelles. But in the large particles of flour more of the carbohydrates and proteins remain unavailable to enzymes. Protein particles do not have time to swell and take part in the formation volumetric of bread crumb.

Coarseness of grinding determine with using sifter of Zhuravlev or a set of sieves. The speed of sifter installs on the 180 – 200 movements per min. From the average sample of flour, we take 100 g (ground - 50 g) and place on a sieve with the appropriate size of the holes (sieve numbers determined by the standards for certain grade of flour). If the humidity of the flour is higher than 16%, then before sifting pre-dried of flour.

For determination coarseness of grinding using:

- in the **high-grade wheat flour** – silk screen No. 43 (the remain on the screen should not be bigger 5%);
- in the **flour of the first grade** – No. 35 (the remain on the screen should not be bigger 2%) and No. 43 (pass through the sieve on the screen should not be smaller 80%);
- in the **flour of the second grade** – No. 27 (the remain on the screen should not be bigger 2%) and No. 38 (pass through the sieve on the screen should not be smaller 65%).

Determine titrated acidity of flour.

Titrated acidity is an indicator of the flour's freshness. The acidity of flour is determined by alcohol and water mixture. Normally, using water mixture. Titrated acidity is expressed in conditional degrees. The number of degrees of acid corresponds to the number of millilitres of normal alkaline solution, which is spent on neutralizing the acids in 100 grams of flour.

To determine the titrated acidity in a conical flask of 150 cm³ pour out 50 cm³ of distilled water then add 5 g of flour. The contents of the flask vigorously shake, so that all the flour to wet. The particles of flour, which remain on the walls of the flask, are washed off. To add 5 drops of 1% solution of phenolphthalein and slowly titrate by decinormal solution of alkali, often shaking the contents of the flask until a pink colour appears, which does not disappear during 1 min.

If after 1 minute after shaking the colour disappears add 2 till 3 drops of phenolphthalein and shake again. When a pink colour appears, titration is considered complete. In parallel, titration is carried out in the second flask and the average arithmetic value is calculated. The difference between the results of two titrations should not exceed 0.2%.

Acidity of flour is determined by the formula:

$$X = (M_T * K * 100 * 100) / (M_H (100 - W) * 10)$$

where M_T – quantity of decinormal solution of alkali which spent for titration, cm³;

M_n – weight of flour sample, g;

K – correction coefficient for transfer of normal solution of alkali to decinormal;

10 – number of transfer of results to a normal solution of alkali;

W – humidity of flour, %.

Questions to the lesson.

1. What is output of flour?
2. Indicate indexes quality which using grinding mixes.
3. Write down methods determination organoleptic indexes quality of flour.
4. Write down method determination infestation of flour by barn pests.
5. Write down method determination acidity of flour.

Lesson 18. Estimation quality of flour by method of laboratory trial baking

Method of laboratory trial baking.

To weigh: 1. flour *wheat* I grade (dry substances) physical weight 100 g. 2. yeast suspension (*yeast* 3 g, water 50 ml). 3. *salt* 1.3 g. 4. *sugar* 2.5 g. 5. total quantity of water according water absorption capacity 71 ml. 6. knead dough carry out with use dough mixer during 7 min.

Total quantity of dough 162.8 g.

Regime fermentation of dough:

1. temperature of fermentation 30-32 °C, 2. humidity of air in the thermostat 80-85 %. 3. duration of the first fermentation 10 min.

Formation and proofing dough:

1. weight of dough 162.8 g. 2. proofing dough in the thermostat 180 min. 3. temp. of the dough proofing 32 °C. 4. total duration of fermentation 180-240 min.

Bread baking:

1. temperature in the bakery chamber 220-230 °C. 2. duration of baking: non-form bread 28 min, form bread 30 min.

Method determination of water absorption capacity. In a porcelain cup in volume of 0.5 l pour the flour almost to the top, inside make a hollow and pour in it 10 cm³ of water. Mix the dough to a consistency so that it does not stick to your hands. To form ball, weigh it and determine the water absorption capacity of the flour X (%) by the formula:

$$X = \frac{10}{M_k - 10} \times 100,$$

where M_k – weight of ball, g.

Determination of bulk bread weight per 100 g of flour with a humidity of 14.5%.

The stability of shape bread is the ratio of its height to diameter. Measure it with either two rulers, or a special device.

The porosity of bread is the ratio of the volume pores of the crumb to the total volume of the crumb.

Organoleptic evaluation of bread. At first, to estimate general appearance and the symmetry form of bread. At the same time inspect its surface, determine the colour, shape, state of crust.

The taste of bread should be characteristic, not sour, not salty, without signs of bitterness, foreign taste and crunch as a result of content of mineral impurities. The smell of bread should be characteristic, without musty smell and other foreign smells. The baking grade of bread has the following gradation: excellent - 4,5 - 5

points, good - 3,8 - 4 points, quite satisfactory - 3,2 - 3,7 points, satisfactory - less than 2,5 points.

Physical indexes quality of bread

| Indexes | According standard |
|--|-----------------------|
| Volume yield of bread from 100 g of flour, ml | 600-1200 and more |
| Acidity, grades (°). | 3-4 |
| Form-stable of bread | corresponding of form |
| Yield of bread (correlation between weight of bread to weight of flour), % | 94-86 |

Questions to the lesson.

1. Write down components which includes to the wheat dough.
2. What indexes quality of bread do you know?
3. Write down duration bread baking.
4. Write down temperature of bread baking.
5. Write down method determination of water absorption capacity.
6. Duration fermentation of wheat dough?

Lesson 19. Determination quality potato tubers

Methods selection samples of potato tubers.

Potato tubers sell by consignments therefore certain quantities of potatoes of the same botanical variety of the same quality and accompanied by a single quality document. The accompanying document must indicate: the date, the name of the sending organization and the recipient, the name of the product, the variety, the weight of consignment, the number of the transport unit.

The potato which delivered in bulk is estimated on the basis of one-time samples, and in the containers - by sample collection. Potatoes with different quality accept with documents on each consignment. In the accompanying invoice to the each of consignment indicated indexes quality.

From every consignment with homogeneous quality of products, laboratory assistants are sampled single samples (with weight 3 kg): from of consignment with weight up to 10 tons – 6 samples, more than 10 tons till 20 tons included – 15, more than 20 till 40 tons included – 21, more than 40 till 70 tons – 24, more than 70 till 150 tons – 30, more than 150 tons for each next 50 tons – 6 samples.

If consignment of potatoes was packed than determine the required quantity of sample collection: from consignment with packages up to 20 included – 3, more than 20 till 50 – 6, more than 50 till 100 – 6, more than 100 till 150 – 12, more than 150 till 200 – 15, more than 250 for each of the next 50 packages (containers) take one-unit additional sample collection.

The weight of a single sample from different layers of bulk or container must be not less than 3 kg. Samples are taken by a wooden shovel, preventing damage to the tubers.

For storage do not use tubers, damaged by late blight of potato and wet rot, as also potatoes which has more than 10% of damaged tubers and more than 5% of the waste (soil, impurities).

Estimation of the quality sample of tubers. At first determine the content of soil. *Free Soil.* The sample weighs and tubers transferred to a clean canvas. The soils which rest on the canvas weigh and determined by its content in the total weight of the sample. *Stuck soil.* We take sample of potato with weight 5 kg, wash it thoroughly during 2 till 3 minutes, permitted to drain of water and weigh. The weight of the stuck soil is express by percentage to a weight of sample 5 kg. At the same time, from the weight of washed tubers subtract 1% on the weight of water remaining on their surface.

Soil on the transport. The mass of free soil and admixtures that left in the transport after unloading the potatoes weigh and calculate their weight in the total weight of consignment.

The total weight of soil is determined as the amount of free soil, stuck soil and admixture in the transport. The result indicates separately from the quality indicators, that is more than 100% with taking into account allowance to the content of soil (1%).

After determining the soil content of the potatoes, the washed tubers are inspected and divided into three fractions: standard, non-standard and technical waste.

To the standard fraction includes healthy, undamaged tubers with certain size in diameter, with damage not more than 5 mm in depth and 10 mm in length, with area of greenish not more than 2 cm², with damage by favus up to 1/4 of the surface.

To non-standard ones apply small tubers which have corresponding size, with area of greenish not more than 1/4 of area, with mechanical damage more than 5 mm in depth and 10 mm in length, parts of the size of more than half of the tubers, damage by favus up to 1/4 of the area and deformed due to unfavourable conditions of cultivation with rind peeled.

To the technical waste apply tubers that do not belong to standard and non-standard ones.

Indicators of quality of tubers are determined predominantly organoleptically and using a ruler or calliper.

Determination of starch in potato tubers. On starch-, alcohol- and canning plants, quantity of starch in the tubers determine with using Parova scales (pic.), photolorimeters and sugar-polarimeters.

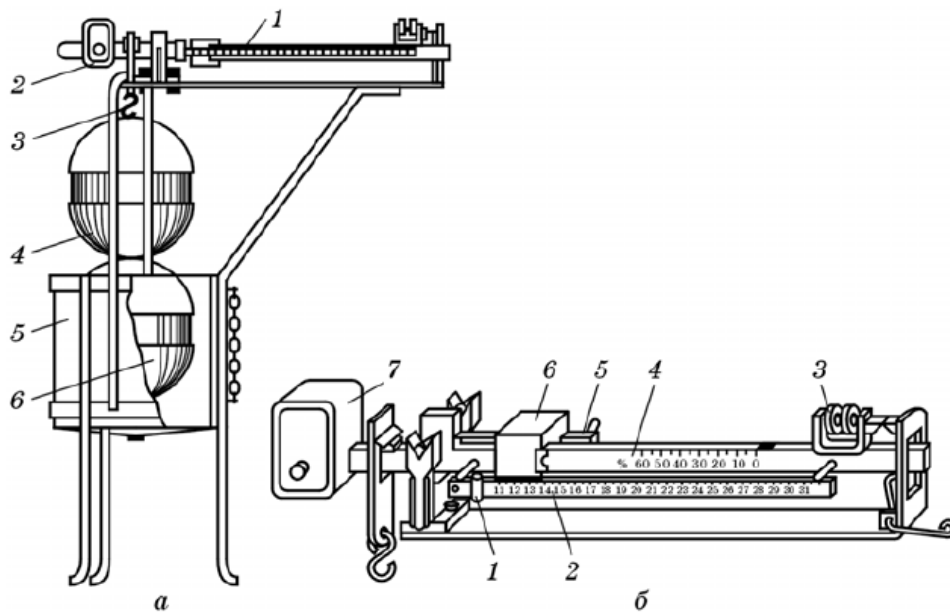


Fig. 8. Parova scale: a - general view: 1 - beam; 2 - counterbalances; 3 - hook; 4, 5 - baskets for determining the content of starch; 6 - a tank for water; b - beam: 1 - weight of starch scale; 2 - the scale of starch; 3 - the mechanism of balancing; 4 - scale of dirty; 5 - tooth of weight; 6 - weight; 7 - counterweights

The content of starch on the Parova scale is determined by the difference in the density of the pulp of potatoes and water (Fig. 8).

If the water temperature is lower or higher than 17.5 °C (at which the scale of balance is calibrated), the result is taken with an adjustment (Table 7).

Table 7: Adjustment for water temperature when determining the content of starch

| Temperature of water, °C | Content starch, % | Temperature of water, °C | Content starch, % |
|--------------------------|-------------------|--------------------------|-------------------|
| Add to the result | | 14 | 0.12 |
| 6 | 0.28 | 15 | 0.09 |
| 7 | 0.27 | 16 | 0.06 |
| 8 | 0.26 | 17 | 0.02 |
| 9 | 0.25 | Minus from the result | |
| 10 | 0.23 | 18 | 0.02 |
| 11 | 0.20 | 19 | 0.80 |
| 12 | 0.18 | 20 | 0.10 |
| 13 | 0.15 | 21 | 0.12 |

Determination of starch content by specific weight of tubers.

Ruler with needle puts on the edges of the vessel so that the needle is sharp pointed to downwards. In the vessel pour 2 – 2.5 liters of water to a certain point or beginning of the needle. Then the ruler is removed, from the vessel in the measuring cylinder gently pour out about 1 litre of water, and in the vessel with the

remainder of the water, hold 1 kg of tubers, putting the ruler with the needle in the previous position, and pour water from the measuring cylinder to the same point. The volume of water in the measuring cylinder is equal to the volume displaced by dried tubers. The volume of water in millilitres corresponds to the same mass in grams.

The specific weight of tubers M_{Π} (kg) is determined by the formula:

$$M_{\Pi} = \frac{M_{\text{б}}}{M_{\text{в}}},$$

where $M_{\text{б}}$ – tubers weighed in the air, g;

$M_{\text{в}}$ – weight of water displaced by tubers, g.

After determining the specific weight of tubers in the special table, find the corresponding value of starch content (appendix).

Questions to the lesson.

1. Write down size average sample of potato tubers.
2. Indicate methods selection of potato tubers which transportation by boxes, containers and by bulk.
3. Describe method determination starch content of potato tuber by specific.
4. What else methods determination starch content of potato tuber do you know?
5. Write down method determination stuck soil in potato tubers.
6. Write down method determination free soil in potato tubers.
7. Write down method determination total weight of soil in potato tubers.

Lesson 20. Storage of potatoes and vegetables in the temporary (field) storehouses

About 50 % potatoes and vegetables are kept in clamps and trenches; it is so-called «field method». It is not easy to store products using a field method, because it is uncomfortable because it does not control quality of products. However, with correct placement of clamps and trenches and laying and covering the loss of production is a minimum (up to 3 – 5 %).

Claps are the long bulks of potatoes, cabbage poured under the certain angle of slope covered hydro- and by warmly-isolation material. They are ground, semi-deepening and deepening (Fig. 5).

Trenches are long ditches, tunnelled in soil on a certain depth and intended for storage of potatoes, root crops and cabbage (Fig. 6). They are deep and shallow. In more northlands one can find wide claps and trenches, in a more south – narrow ones.

Claps and trenches are allocated in pairs from north to south, so that during the day the sun equally heats both sides.

Passages of 7-8 m wide are between the pair of claps and trenches, between individual claps and trenches one can see alleyways of 4-6 m wide.

Claps and trenches are covered with soil, straw, peat, brushwood, dry manure.

Coverings can have a bilayer – a layer of straw and soil – and a four-layer (in addition to the previous layers another layer of straw and soil). The thickness of cover is determined on the base of soil freezing.

Calculation of the volume of storage required to store potatoes, fruits and vegetables.

This carried out calculation gave the bulk density, size and form of storage.

The bulk density (kg/m^3):

potatoes – 650-700;

carrots - 550-600;

cabbages - 360-450;

beets – 600;

onions - 550-600;

garlic - 400-430.

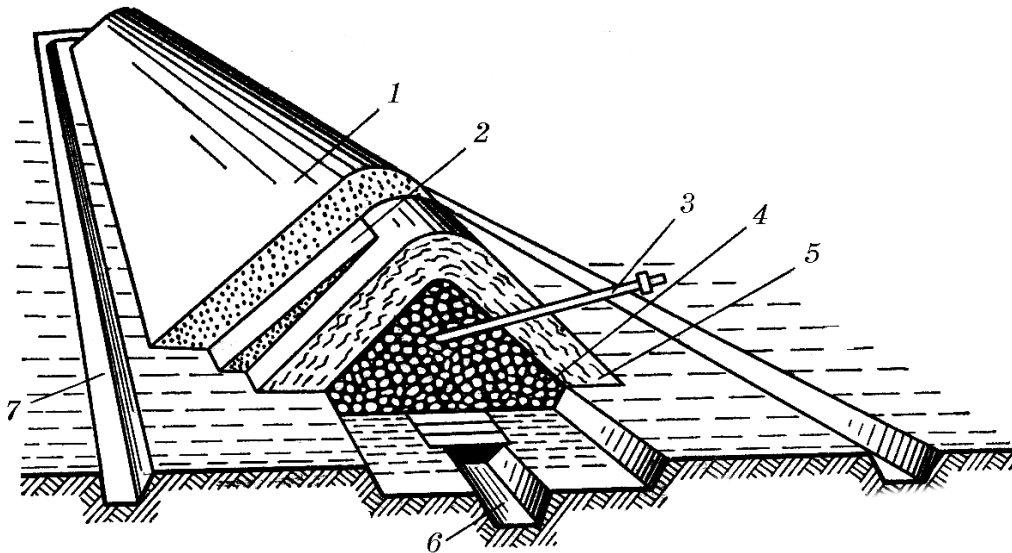


Fig. 5. Clamps of potatoes (cross-section): 1 – layer of soil; 2 – additional cover layer at the bottom; 3 – thermometer; 4 – products; 5 – a layer of straw; 6 – forced ventilation pipe; 7 – drainage ditch

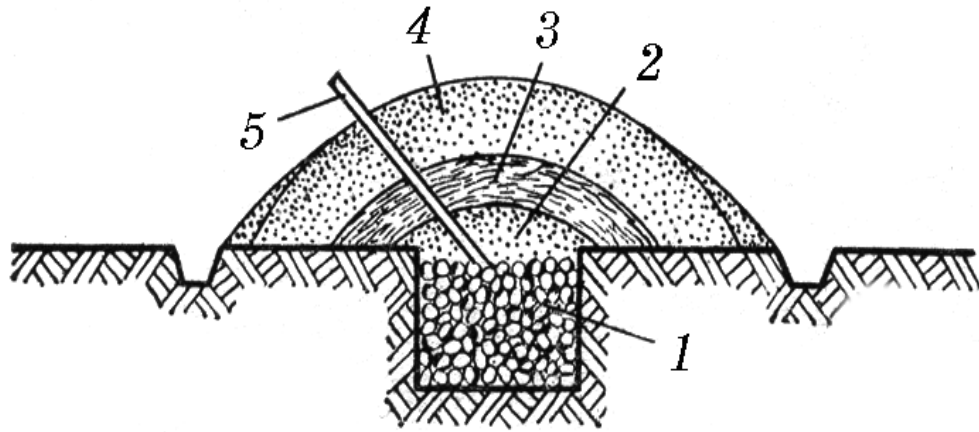


Fig. 6. Cross-section of trench: 1 – products; 2 – layer of soil; 3 – layer of straw; 4 – cover soil; 5 – thermometer

Questions to the lesson.

1. What are clamps?
2. What are trenches?
3. What determines the thickness of cover the claps and trenches?
4. What materials are used for cover the claps and trenches?
5. Indicate how location the claps and trenches relatively two sides of world.
6. Write down sizes of clamps and trenches depending on region of their location.
7. Indicate sizes of passages and alleyways between the pair and individual clamps and trenches.

Lesson 21. Organization storage of fruits and vegetables

Once fruit is harvested, any natural resistance to the action of spoiling micro-organisms is lost. Changes in enzymatic systems of the fruit also occur on harvest which may also accelerate the activity of spoilage organisms.

Means that are commonly used to prevent spoilage of fruits must include:
 care to prevent cutting or bruising of the fruit during picking or handling;
 refrigeration to minimise growth of micro-organisms and reduce enzyme activity;

packaging or storage to control respiration rate and ripening;
 use of preservatives to kill micro-organisms on the fruit.

A principal economic loss occurring during transportation and/or storage of produce such as fresh fruit is the degradation which occurs between the field and the ultimate destination due to the effect of respiration. Methods to reduce such degradation are as follows:

- refrigerate the produce to reduce the rate of respiration;
- vacuum cooling;
- reduce the oxygen content of the environment in which the produce is kept to a value not above 5% of the atmosphere but above the value at which

anaerobic respiration would begin. When the oxygen concentration is reduced within 60 minutes the deterioration is in practice negligible.

The following is a summary of some recent developments in post-harvest technology of fresh fruits and vegetables (Source: Thompson, 1989).

Harvest maturity. This is particularly important with fruit for export. One recent innovation is the measurement of resonant frequency of the fruit which should enable the grading out of over mature and under-mature fruit before they are packed for export.

Controlled ripening.

Maturity at harvest is the key factor for quality and postharvest life. When shipped to distant markets, fruits need to be harvested slightly immature (particularly climacteric ones) to reduce bruising and losses during transport. Prior to distribution and retail sales, however, it is necessary to speed up and achieve uniform ripening. The main reason for this is so that product reaches consumers at the right stage of maturity. As with degreening, ethylene is used but at higher concentrations. Banana provides a typical example of this type of operation. It can however, also be carried out on tomatoes, melons, avocados, mangoes and other fruits (Table 8).

Table 8: Conditions for controlled ripening of some fruits

| | Ethylene concentration (ppm) | Ripening temperature °C | Exposure time to these conditions (hr.) |
|----------------|------------------------------|-------------------------|---|
| Avocado | 10-100 | 15-18 | 12-48 |
| Banana | 100-150 | 15-18 | 24 |
| Honeydew melon | 100-150 | 20-25 | 18-24 |
| Kiwifruit | 10-100 | 0-20 | 12-24 |
| Mango | 100-150 | 20-22 | 12-24 |
| Stone fruits | 10-100 | 13-25 | 12-72 |
| Tomato | 100-150 | 20-25 | 24-48 |

Controlled ripening is performed in purpose built rooms where temperature and relative humidity can be controlled and ethylene removed when the process has been completed. The process involves initial heating to reach the desired pulp temperature. This is followed by an injection of ethylene at the desired concentration. Under these conditions, the product is maintained for a certain amount of time followed by ventilation in order to remove accumulated gases. On completion of the treatment, the temperature is reduced to the desired level for transportation and/or storage. Ethylene concentration and exposure time are a function of temperature, which accelerates the process.

Harvest method. Considerable research is continuing on mechanical harvesting of perishable crops with a view to minimising damage. In fruit trees,

controlling their height by use of dwarfing rootstocks, pruning and growth regulating chemicals will lead to easier, cheaper more accurate harvesting.

Handling systems. Field packing of various vegetables for export has been carried out for many years. In the last decade or so this has been applied, in selected cases, to a few tropical fruit types. Where this system can be practiced it has considerable economic advantages in saving the cost of building, labour and equipment and can result in lower levels of damage into crops.

Pre-cooling. Little innovation has occurred in crop pre-cooling over the last decade. However high velocity, high humidity forced air systems have continued to be developed and refined. These are suitable for all types of produce and are relatively simple to build and operate and, while not providing the speed of cooling of a vacuum or hydrocooler, have the flexibility to be used with almost all crops.

Chemicals. There is a very strong health lobby whose objective is to reduce the use of chemicals in agriculture and particularly during the post-harvest period. Every year sees the prohibition of the use of commonly used post-harvest chemicals. New ways need to be developed to control post-harvest diseases, pest and sprouting.

Coatings. Slowing down the metabolism of fruit and vegetables by coating them with a material which affects their gaseous exchange is being tested and used commercially on a number of products.

Controlled environment transport. Recent innovations in this technique have produced great progress as a result of the development and miniaturisation of equipment to measure carbon dioxide and oxygen. Several companies now offer containers where the levels of these two gases can be controlled very precisely.

Table 9: Recommended temperature and relative humidity for fruits and vegetables and the approximate storage life under these conditions

| Crop | Temperature (°C) | Relative Humidity (%) | Storage Life (days) |
|------------------|------------------|-----------------------|---------------------|
| Apple | -1-4 | 90-95 | 30-180 |
| Apricot | -0.5-0 | 90-95 | 7-21 |
| Bean (dry) | 4-10 | 40-50 | 180-300 |
| Beet (bunched) | 0 | 98-100 | 10-14 |
| Beet (topped) | 0 | 98-100 | 120-180 |
| Blackberry | -0.5-0 | 90-95 | 2-3 |
| Blueberries | -0.5-0 | 90-95 | 14 |
| Broccoli | 0 | 95-100 | 14-21 |
| Cabbage | 0 | 98-100 | 150-180 |
| Carrot (bunched) | 0 | 95-100 | 14 |
| Carrot (topped) | 0 | 98-100 | 210-270 |
| Cauliflower | 0 | 95-98 | 21-28 |
| Cucumber | 10-13 | 95 | 10-14 |

| | | | |
|----------------|----------|-------|---------|
| Eggplant | 8-12 | 90-95 | 7 |
| Garlic | 0 | 65-70 | 180-210 |
| Grape | -0.5-0 | 90-95 | 14-56 |
| Grapefruit | 10-15 | 85-90 | 42-56 |
| Lemon | 10-13 | 85-90 | 30-180 |
| Lime | 9-10 | 85-90 | 42-56 |
| Onions (dry) | 0 | 65-70 | 30-240 |
| Orange | 0-9 | 85-90 | 56-84 |
| Peach | -0.5-0 | 90-95 | 14-28 |
| Pear | -1.5-0.5 | 90-95 | 60-210 |
| Peas | 0 | 95-98 | 7-14 |
| Cucumber | 5-10 | 95 | 28 |
| Pepper (bell) | 7-13 | 90-95 | 14-21 |
| Plum | -0.5-0 | 90-95 | 14-35 |
| Potato (early) | 7-16 | 90-95 | 10-14 |
| Potato (late) | 4.5-13 | 90-95 | 150-300 |
| Pumpkins | 10-15 | 50-70 | 60-160 |
| Strawberry | 0-0.5 | 90-95 | 5-7 |
| Sweet corn | 0-1.5 | 95-98 | 5-8 |
| Tomato (MG) | 12.5-15 | 90-95 | 14-21 |
| Tomato (red) | 8-10 | 90-95 | 8-10 |

Questions to the lesson.

1. Write down factors that affecting on the storage life of fruit and vegetable?
2. Indicate regimes storage of garlic and onions?
3. How influence coatings of products on the its quality?
4. Indicate regimes storage of apple and pear?
5. Indicate regimes storage of plum and peach?

Lesson 22. Production of the pickle cabbage

Chemical food preservation. Many chemicals will kill microorganisms or stop their growth but most of these are not permitted in foods; chemicals that are permitted as food preservatives are listed in Table 10. Chemical food preservatives are those substances which are added in very low quantities (up to 0.2%) and which do not alter the organoleptic and physico-chemical properties of the foods at or only very little.

Preservation of food products containing chemical food preservatives is usually based on the combined or synergistic activity of several additives, intrinsic

product parameters (e.g. composition, acidity, water activity) and extrinsic factors (e.g. processing temperature, storage atmosphere and temperature).

Table 10: Chemical Food Preservatives

| Agent | Acceptable Daily intake (mg/Kg body weight) | Commonly used levels (%) |
|-------------------|---|--------------------------|
| Lactic acid | No limit | No limit |
| Citric acid | No limit | No limit |
| Acetic acid | No limit | No limit |
| Sodium Diacetate | 15 | 0.3-0.5 |
| Sodium benzoate | 5 | 0.03-0.2 |
| Sodium propionate | 10 | 0.1-0.3 |
| Potassium sorbate | 25 | 0.05-0.2 |
| Methyl paraben | 10 | 0.05-0.1 |
| Sodium nitrite | 0.2 | 0.01-0.02 |
| Sulphur dioxide | 0.7 | 0.005-0.2 |

This approach minimises undesirable changes in product properties and reduces concentration of additives and extent of processing treatments.

The concept of combinations of preservatives and treatments to preserve foods is frequently called the hurdle or barrier concept. Combinations of additives and preservatives systems provide unlimited preservation alternatives for applications in food products to meet consumer demands for healthy and safe foods.

Chemical food preservatives are applied to foods as direct additives during processing, or develop by themselves during processes such as fermentation. Certain preservatives have been used either accidentally or intentionally for centuries, and include sodium chloride (common salt), sugar, acids, alcohols and components of smoke. In addition to preservation, these compounds contribute to the quality and identity of the products, and are applied through processing procedures such as salting, curing, fermentation and smoking.

Preservation of vegetables by acidification. Food acidification is a means of preventing their deterioration in so far as a non-favourable medium for micro-organisms development is created. This acidification can be obtained by two ways: natural acidification and artificial acidification.

Natural acidification. This is achieved by a predominant lactic fermentation which assures the preservation based on acidoceno-anabiosis principle; preservation by lactic fermentation is called also biochemical preservation.

Throughout recorded history food has been preserved by fermentation. In spite of the introduction of modern preservation methods, lactic acid fermented vegetables still enjoy a great popularity, mainly because of their nutritional and gastronomic qualities.

The various preservation methods discussed thus far, based on the application of heat, removal of water, cold and other principles, all have the common objective of decreasing the number of living organisms in foods or at least holding them in check against further multiplication.

Fermentation processes for preservation purposes, in contrast, encourage the multiplication of micro-organisms and their metabolic activities in foods. But the organisms that are encouraged are from a select group and their metabolic activities and end products are highly desirable. The extent of this desirability is emphasised by a partial list of fermented fruits and vegetable products from various parts of the world in Table 11.

Table 11: Some industrial fermentation processes in food industries

| | |
|---|----------------------------|
| I. Lactic acid bacteria | |
| - cucumbers | dill pickles, sour pickles |
| - cabbage | sauerkraut |
| - turnips | sauerruben |
| - lettuce | lettuce kraut |
| - mixed vegetables, turnips, radish, cabbage | |
| - mixed Chinese vegetables, | |
| cabbage | Kimchi |
| - vegetables and milk | Tarhana |
| - vegetables and rice | Sajur asin |
| II. Lactic acid bacteria with other micro-organisms | |
| - with yeasts | Nukamiso pickles |
| - with moulds | tempeh, soy sauce |
| III. Acetic acid bacteria - wine, cider or any alcoholic and sugary or starchy products may be converted to vinegar | |
| IV. Yeasts | |
| - fruit | wine, vermouth |

There are some characteristic features in the production of fermented vegetables which will be pointed out below using cucumbers as an example. In the

production of lactic acid fermented cucumbers, the raw material is put into a brine without previous heating. Through the effect of salt and oxygen deficiency the cucumber tissues gradually die. At the same time, the semi-permeability of the cell membranes is lost, whereby soluble cell components diffuse into the brine and serve as food substrate for the micro-organisms.

Under such specific conditions of the brine the lactic acid bacteria succeed in overcoming the accompanying micro-organisms and lactic acid as the main metabolic products is formed. Under favourable conditions (for example moderate salt in the brine, use of starter cultures) it takes at least 3 days until the critical pH value of 4.1 or less - desired for microbiological reasons - is reached.

Beside the typical taste, for the consumer a crisp texture is the most important quality criterion for fermented vegetables. Fig. 9 shows the factors which can influence the texture, where the enzymes are particularly important.

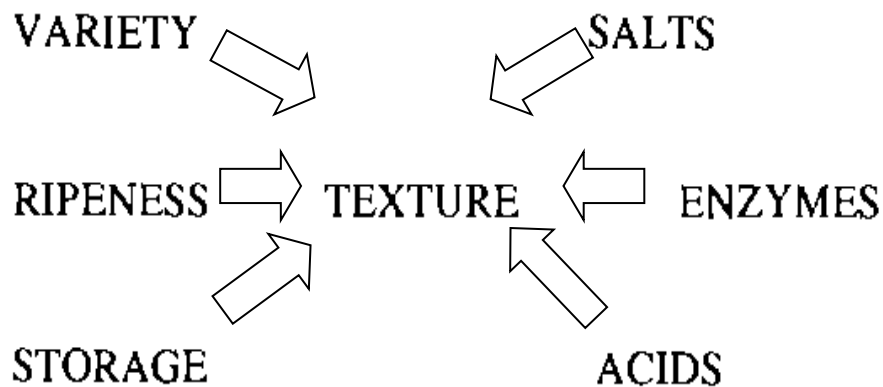


Fig. 9. Factors influencing the texture of fermented vegetables

Because there is no heating step before the fermentation, the indigenous plant enzymes in the fermenting materials are still present during the very first phase. After the destruction of the cell membranes they easily get to their active sites and under favourable conditions they can easily cause softening.

The environmental conditions act in a different manner on single enzymes or enzymes systems: some enzymes are strongly inhibited by salt, others are activated, and in the acid pH-region many enzymes are irreversibly inactivated. Beside indigenous enzymes also enzymes produced by micro-organisms can be responsible for the undesired soft products.

In technically advanced societies the major importance of fermented foods has come to be variety they add to the diet. However, in many less developed areas of the world, fermentation and natural drying are the major food preservation methods and as such are vital to survival of a large proportion of the world's current population.

Artificial acidification is carried out by adding acetic acid which is the only organic acid harmless for human health and stable in specific working conditions;

in this case biological principles of the preservation are acidoanabiosys and, to a lesser extent, acidoabiosys.

Combined acidification is a preservation technology which involves as a preliminary processing step a weak lactic fermentation followed by acidification (vinegar addition).

The two main classes of vegetables preserved by acidification are sauerkraut and pickles are as follows.

Bulk sauerkraut. Bulk or barrelled sauerkraut is the product of characteristic acid flavour, obtained by the full fermentation, chiefly lactic, of properly prepared and shredded cabbage in the presence of 2-3% salt. On completion of fermentation, it contains not more than 1.5% of acid, expressed as lactic acid.

Canned sauerkraut. Canned (or packaged) sauerkraut, is prepared from clean, sound, well-matured heads of the cabbage plant (*Brassica oleracea* var. *capitata* L.) which have been properly trimmed and cut; to which salt is added and which is cured by natural fermentation.

The product may or may not be packed with pickled peppers, pimientos, or tomatoes or contain other flavouring ingredients to give the product specific flavour characteristics. The product

a) may be canned by processing sufficiently by heat to assure preservation in hermetically sealed containers; or

b) may be packaged in sealed containers and preserved with or without the addition of benzoate of soda or any other ingredient permissible under the provisions of Food and Drug Administration (FDA).

Pickles. "Pickles" means the product prepared entirely or predominantly from cucumbers (*Cucumis sativus* L.). Clean, sound ingredients are used which may or may not have been previously subjected to fermentation and curing in a salt brine (solution of sodium chloride, NaCl).

The prepared pickles are packed in a vinegar solution to which may be added salt and other vegetables, nutritive sweeteners, seasonings, flavourings, spices, and other ingredients permissible under FDA regulations. The product is packed in suitable containers and heat treated, or otherwise processed to assure preservation.

Sauerkraut and pickle products can be preserved under the effect of natural or added acidity, followed by pasteurization when this acidification is not sufficient.

Sauerkraut is a very good source of vitamin C; the importance of this product should be emphasised in developing countries as a simple technology which can be applied mainly for consumption of the finished products in remote, isolated areas during the cold season. It is also a excellent technology to be learned to schools which have their own source of cabbage and cucumbers through school agricultural farms.

Sauerkraut and pickles are manufactured on an industrial scale in significant quantities world-wide. However, the basic technology is simple and could be applied at home, farm and community level after some explanation and training.

The natural acidification preservation could be considered similar to sun/solar drying in terms of training and development.

Questions to the lesson.

1. Write down factors that affect the texture of product during fermentation.
2. Indicate chemical food preservatives.
3. Write down preservative which is used for production of sauerkraut.
4. What other industrial fermentation processes in food industries do you know?

Lesson 23. Estimation quality of the sugar beets of technical purpose

Determination of certified of sugar beets. Certified are sugar beets that required to standard of the sugar beet for industrial processing. Certified is evaluated organoleptically with indication the presence of green stalk, blossoming, flabby, frozen, mechanically damaged root.

To the certified apply beets in the turgor state. It is checked by breaking off the end of beet with thick 1 cm. Certified by turgor is also determined by laboratory: from the root crops cut off plates with thick 0.5 cm total area of 30 - 50 cm², weighed them and dived into water. After 1 – 2 hours they are taken out and soaked by cloth water from the surface. The plates are weighed and determine the content of the absorb water. If it exceeds 5%, then the root crop is considered friable.

In a consignment of certified beets, there should not be more than 1% of flowering root crops, 12% with highly mechanically damaged (1/3 and more), 5% friable and 3% with green stalk. If sugar beet does not meet the requirements of the standard at least one of these indicators, they are classified as uncertified.

Such beets are paid with discount at 20%. The certified of the beet consignment is determined in the laboratory. For analysis in three places of the consignment (along diagonally) manually take a sample with weight 10 - 15 kg and evaluate them.

Saccharinity and dirtiness of beets are determined by the laboratory. Samples are taken from each 5th-10th consignment. The dirtiness of root crops is not standardized, but the weight of admixtures is not counted in the acceptable weight. Indicator of basic sugar content is set for each plant separately (average over the last 5 years).

Samples for determination admixtures and sugar content are taken from transportation units by mechanical sampler «Rypro».

To take sample with weight 10-12 kg (M_1), weigh it and wash it by mechanical washer. On the conveyor, the root crops are manually cleaned from the sugar beet tops and selected small roots with diameter less than 1 cm. The root crops are weighed on automatic balance and the result M_2 is used to determine the admixtures by the formula:

$$X = \frac{M_1 - M_2}{M_1} \cdot 100$$

Then a pure sample enters the line of determination of sugar content. The main indicator of the productivity of root crops is soundness of their juice. It is determined by the quantity parts of sucrose in 100 parts of dry matter of normal juice of root crops. Than higher soundness of juice, therefore more valuable for sugar beet root crops for industrial production. Soundness characterizes the purity of juice.

Determination of the content of soluble solids substances is based on the fact that the rays of light passing through solutions of different concentrations are refracted differently. As the concentration of the solution increases, the refractive index of the rays is higher. It defines by refractometers.

Sucrose content determines by way direct polarization. The content of sucrose is determined using its optical effect, that is, the ability to rotate the plane of polarization. In this case, universal polarimeters and polarimeters-sugar meters are used. The sucrose is mainly determined by the methods of hot and cold water digestion. By content of soluble dry matter and sugar content determine the soundness of juice of sugar beet, using the formula:

$$D = \frac{C \cdot 100}{P},$$

where D - soundness of normal juice;

C - sucrose content, %;

P - content of dry soluble substances for refractometer, %.

The technical value of beets Π (the quantity kilograms of sugar that can be obtained from 100 kg of beets) calculated on the basis of the sugar content of beets C and the soundness of normal juice D .

$$\Pi = \frac{C \cdot D}{100}$$

Under normal conditions, the soundness of sugar beet which arrive on the processing from enterprises is 84 - 89%. In the storage of root crops, this indicator can be reduced, and in the process of sugar production it is raised to 90 - 95% by releasing juice from non-sugars, subsequent evaporation and boiling.

Questions to the lesson.

1. Write down methods determination certified of sugar beets.
2. Indicate ways determination content of soluble solids substances.
3. Which ways determination content of sucrose do you know?
4. Write down formula for determination soundness of juice of sugar beet.
5. What is calculate technical value of beets?

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Appendixes

Wheat. Grades and Grade Requirements according of USA standards

| | Grades U.S. Nos. ¹ | | | | |
|---|-------------------------------|------|------|------|------|
| Grading Factors | 1 | 2 | 3 | 4 | 5 |
| <i>Minimum pound limits of:</i> | | | | | |
| Test Weight | | | | | |
| Hard Red Spring wheat or White Club wheat (lbs/bu) | 58.0 | 57.0 | 55.0 | 53.0 | 50.0 |
| All other classes and subclasses (lbs/bu) | 60.0 | 58.0 | 56.0 | 54.0 | 51.0 |
| <i>Maximum percent limits of:</i> | | | | | |
| Defects | | | | | |
| Damaged kernel | | | | | |
| Heat (part of total) | 0.2 | 0.2 | 0.5 | 1.0 | 3.0 |
| Total | 2.0 | 4.0 | 7.0 | 10.0 | 15.0 |
| Foreign material | 0.4 | 0.7 | 1.3 | 3.0 | 5.0 |
| Shrunken and broken kernels | 3.0 | 5.0 | 8.0 | 12.0 | 20.0 |
| Total ¹ | 3.0 | 5.0 | 8.0 | 12.0 | 20.0 |
| Wheat of other classes² | | | | | |
| Contrasting classes | 1.0 | 2.0 | 3.0 | 10.0 | 10.0 |
| Total ³ | 3.0 | 5.0 | 10.0 | 10.0 | 10.0 |
| Stones | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| <i>Maximum count limits of:</i> | | | | | |
| Other material | | | | | |
| Animal filth | 1 | 1 | 1 | 1 | 1 |
| Castor beans | 1 | 1 | 1 | 1 | 1 |
| Crotalaria seeds | 2 | 2 | 2 | 2 | 2 |
| Glass | 0 | 0 | 0 | 0 | 0 |
| Stone | 3 | 3 | 3 | 3 | 3 |
| Unknown foreign substance | 3 | 3 | 3 | 3 | 3 |
| Total⁴ | 4 | 4 | 4 | 4 | 4 |
| Insect-damaged kernels in 100 grams | 31 | 31 | 31 | 31 | 31 |

U.S. Sample Grade

Wheat that:

- (a) Does not meet the requirements for U.S. Nos. 1, 2, 3, 4, or 5; or
 (b) Has a musty, sour, or commercially objectionable foreign odor (except smut or garlic odor); or
 (c) Is heating or of distinctly low quality.

¹Includes damaged kernels (total), foreign material, and shrunken and broken kernels.²Unclassed wheat of any grade may contain not more than 10.0 percent of wheat of other classes.³Includes contrasting classes.⁴Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, or unknown foreign substance.

**Restrictive-control norms of
natural losses of grain storage, %**

| Grain (seed) and its processed products | Term storage | In warehouses | | In elevators | On adapted to storage sites |
|---|-----------------|---------------|--------------|--------------|-----------------------------|
| | | bulk | in container | | |
| Wheat, rye, barley, spelt | Up to 3 months. | 0,07 | 0,04 | 0,05 | 0,12 |
| | Up to 6 months. | 0,09 | 0,06 | 0,07 | 0,16 |
| | Up to 1 year | 0,12 | 0,09 | 0,10 | - |
| Oats | Up to 3 months | 0,09 | 0,05 | 0,06 | 0,15 |
| | Up to 6 months | 0,13 | 0,07 | 0,08 | 0,20 |
| | Up to 1 year | 0,17 | 0,09 | 0,12 | - |
| Buckwheat, rice | Up to 3 months | 0,08 | 0,05 | 0,06 | - |
| | Up to 6 months. | 0,11 | 0,07 | 0,08 | - |
| | Up to 1 year | 0,15 | 0,10 | 0,12 | - |
| Millet, Foxtail millet, sorghum | Up to 3 months | 0,11 | 0,06 | 0,07 | 0,14 |
| | Up to 6 months. | 0,15 | 0,08 | 0,09 | 0,19 |
| | Up to 1 year | 0,19 | 0,10 | 0,14 | - |
| Corn | Up to 3 months | 0,13 | 0,07 | 0,08 | 0,18 |
| | Up to 6 months. | 0,17 | 0,10 | 0,12 | 0,22 |
| | Up to 1 year | 0,21 | 0,13 | 0,16 | - |
| Cornbob | Up to 3 months | 0,25 | - | - | 0,45 |
| | Up to 6 months. | 0,30 | - | - | 0,55 |
| | Up to 1 year | 0,45 | - | - | 0,70 |
| Peas, lentils, bean, haricot bean, vetch, soybean | Up to 3 months | 0,07 | 0,04 | 0,05 | - |
| | Up to 6 months. | 0,09 | 0,06 | 0,07 | - |
| | Up to 1 year | 0,12 | 0,08 | 0,10 | - |
| Sunflower | Up to 3 months | 0,20 | 0,12 | 0,14 | 0,24 |
| | Up to 6 months. | 0,25 | 0,15 | 0,18 | 0,30 |
| | Up to 1 year | 0,30 | 0,20 | 0,23 | - |
| Other oilseeds | Up to 3 months. | 0,10 | 0,08 | - | - |
| | Up to 6 months. | 0,13 | 0,11 | - | - |
| | Up to 1 year | 0,17 | 0,14 | - | - |
| Cereals, including rice | Up to 3 months. | - | 0,04 | - | - |
| | Up to 6 months. | - | 0,06 | - | - |
| | Up to 1 year | - | 0,09 | - | - |
| Flour | Up to 3 months | - | 0,05 | - | - |
| | Up to 6 months. | - | 0,07 | - | - |
| | Up to 1 year | - | 0,10 | - | - |
| Bran and flour | Up to 3 months | 0,20 | 0,12 | - | - |
| | Up to 6 months. | 0,25 | 0,16 | - | - |
| | Up to 1 year | 0,35 | 0,20 | - | - |

The requirements to the grain of soft wheat

| Indexes | The norms of classes for soft wheat | | | |
|---|-------------------------------------|--------|-----------|--------------------------------|
| | 1 | 2 | 3 | 4 |
| Grain-unit, g/l, no less than | 775 | 750 | 730 | Unlimited |
| Vitreous, %, no less than | 50 | 40 | Unlimited | Unlimited |
| Humidity, %, no more than | 14.0 | 14.0 | 14.0 | 14.0 |
| Grain admixture, %, no more than | 5.0 | 8.0 | 8.0 | 15.0 |
| Especially: | | | | |
| the broken grain | 5.0 | 5.0 | 5.0 | Within the grain admixture |
| the grain of cereals | 3.0 | 4.0 | 4.0 | Within the grain admixture |
| sprout grain | 2.0 | 3.0 | 3.0 | Within the grain admixture |
| Foreign impurity, %, no more than | 1.0 | 2.0 | 2.0 | 3.0 |
| Especially: | | | | |
| mineral admixture | 0.3 | 0.5 | 0.5 | 1 |
| Especially: | | | | |
| pebble, slag, ore | 0.15 | 0.15 | 0.15 | 0.15 |
| spoiled grain | 0.3 | 0.5 | 0.5 | 1 |
| Especially: | | | | |
| fuzarious grain | 0.3 | 0.5 | 0.5 | 1 |
| harmful admixture | 0.1 | 0.1 | 0.2 | 0.2 |
| Especially: | | | | |
| Smut and ergot (together) | 0.05 | 0.05 | 0.05 | 0.1 (0.05 smut and 0.05 ergot) |
| Trichodesma incanum | Exclude | | | |
| cockle | Within the harmful admixture | | | |
| every of the sorts of other toxic grain | 0.05 | 0.05 | 0.05 | 0.05 |
| Smutty grain, %, no more than | 8.0 | 8.0 | 8.0 | 10.0 |
| Mass part of protein in re-calculation on dry substance, %, no less than | 14.0 | 12.5 | 11.0 | Unlimited |
| Mass part of row gluten, %, no less than | 28.0 | 23.0 | 18.0 | Unlimited |
| Quality of gluten: units of device VDK | 45-100 | 45-100 | 45-100 | Unlimited |
| The number of falling, sec, no less than | 220 | 220 | 180 | Unlimited |

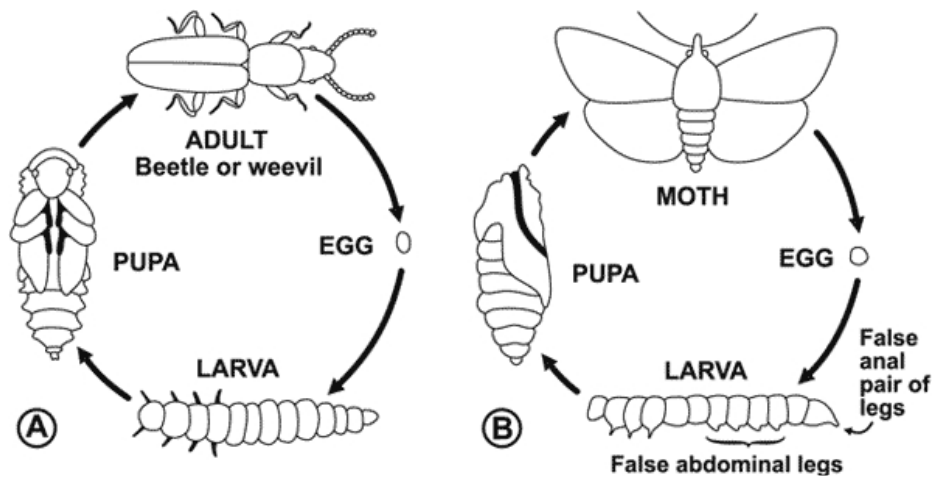


Fig. 1. Life cycles of stored-product insects: A, a beetle and B, a moth



A – The grain mite (left);



B – Warty grain mite (right);



C – Mould mite (left);



D – Longhaired mite (right);



E – Glossy grain mite female viewed from above (left);



F – Glossy grain mite female viewed from the side (right)

Fig. 2. Some major stored product mites as viewed by scanning electron microscope.

Stored-product beetles

| Common Name | Scientific Name | Adult colour | Adult length (mm) | Antennae | Can climb glass | Can fly |
|-----------------------------|---|-------------------|-------------------|----------|-----------------|---------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| American black flour beetle | <i>Tribolium audax</i> | dark brown, black | 3-4 | clubbed | no | no |
| Cadelle | <i>Tenebroides mauritanicus</i> | Dark brown, black | 6-10 | clubbed | no | yes |
| Confused flour beetle | <i>Tribolium confusum</i> | reddish brown | 2-4 | clubbed | no | no |
| European black flour beetle | <i>Tribolium madens</i> | Dark brown, black | 4-5 | clubbed | no | yes |
| Flat grain beetle | <i>Cryptolestes pusillus</i> | reddish brown | 2 | thread | no | yes |
| Foreign grain beetle | <i>Ahasverus advena</i> | Brown | 2 | clubbed | yes | yes |
| Granary weevil | <i>Sitophilus granarius</i> | Dark brown, black | 3-4 | clubbed | yes | no |
| Hairy spider beetle | <i>Ptinus villiger</i> | Brown | 2-4 | thread | yes | no |
| Lesser grain borer | <i>Rhyzopertha dominca</i> | dark brown | 2-3 | clubbed | no | yes |
| Psocids | <i>Lepinotus reticulatus</i> <i>Liposcelis bostrychophilus</i> | light brown | 1 | thread | yes | yes |
| Red flour beetle | <i>Tribolium castaneum</i> | reddish brown | 2-4 | clubbed | no | yes |
| Rice weevil | <i>Sitophilus oryzae</i> | Dark brown, black | 3-4 | clubbed | yes | yes |

Stored-product moths

| Common Name | Scientific Name | Adult colour | Adult length (mm) | Antennae | Can climb glass | Can fly |
|----------------------------|--------------------------------------|-----------------|-------------------|----------|-----------------|---------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Brown house moth | <i>Hofmannophila pseudospretella</i> | brown | 8-11 | thread | yes larvae | yes |
| Indianmeal moth | <i>Plodia interpunctella</i> | cream and brown | 8-10 | thread | yes larvae | yes |
| Meal moth | <i>Pyralis farinalis</i> | brown and tan | 15-20 | thread | yes larvae | yes |
| Mediterranean flour moth | <i>Ephestia kuehniella</i> | gray and black | 10-15 | thread | yes larvae | yes |
| Whiteshouldered house moth | <i>Endrosis sarcitrella</i> | white | 8-11 | thread | yes larvae | yes |

Stored-product mites

| Common Name | Scientific Name | Adult colour | Adult length (mm) | Antennae | Can climb glass | Can fly |
|-------------------|---------------------------------|----------------|-------------------|----------|-----------------|---------|
| cannibal mite | <i>Cheyletus eruditus</i> | white | 0.4-0.6 | - | yes | no |
| glossy grain mite | <i>Tarsonemus granarius</i> | orange, yellow | 0.1-0.2 | - | yes | no |
| grain mite | <i>Acarus siro</i> | white, tan | 0.3-0.6 | - | yes | no |
| longhaired mite | <i>Lepidoglyphus destructor</i> | white | 0.3-0.5 | - | yes | no |
| mould mite | <i>Tyrophagus putrescentiae</i> | white | 0.3-0.5 | - | yes | no |

The requirements to the grain of hard wheat

| Indexes | The description and norm by classes for hard wheat | | | | |
|--|--|------|------|------|------------------------------|
| | 1 | 2 | 3 | 4 | 5 |
| The grain of soft wheat , %, no less than | 4 | 4 | 8 | 10 | Unlimited |
| Grain - unit , g/l, no less than | 750 | 750 | 730 | 710 | Unlimited |
| Humidity , %, no more than | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Vitreous , %, no less than | 70 | 60 | 50 | 40 | Unlimited |
| Grain admixture , %, no more than | 5.0 | 5.0 | 8.0 | 10.0 | 15.0 |
| Especially: sprout grain | 1.0 | 1.0 | 3.0 | 3.0 | Within the grain admixture |
| Foreign material , %, no more than | 2.0 | 2.0 | 2.0 | 5.0 | 5.0 |
| Especially: mineral admixture | 0.3 | 0.3 | 0.5 | 0.5 | 1.0 |
| Especially: pebble, slag, ore | 0.15 | 0.15 | 0.2 | 0.3 | Within the mineral admixture |
| spoiled grain | 0.2 | 0.2 | 0.5 | 1.0 | 1.0 |
| Especially: fuzarious grain | Within the spoiled grains | | | | |
| harmful admixture | 0.2 | 0.3 | 0.5 | 0.5 | 0.5 |
| Especially: smut, ergot | 0.05 | 0.05 | 0.1 | 0.1 | 0.1 |
| Trichodesma incanum | Disallow | | | | |
| cockle | Within the harmful admixture | | | | |
| every of the sorts of other toxic grain | 0.05 | 0.05 | 0.05 | 0.05 | 0.1 |
| Smut grain , %, no more than | 5.0 | 5.0 | 5.0 | 5.0 | 10.0 |
| Mass part of protein in re-calculation on dry substance , %, no less than | 14.0 | 13.0 | 12.0 | 11.0 | Unlimited |
| The number of falling , sec, no less than | 220 | 200 | 150 | 100 | Unlimited |

The requirements to the grain of barley

| Parameters | The characteristic and norm for soft barley for class and assignment | | | | |
|---|--|-------------------------------------|-----------|---------------|------|
| | food | produce of malt (in spirit produce) | forage | brewage | |
| | class | | | | |
| | 1 | 2 | 3 | 1 | 2 |
| Humidity, %, no more than | 14.5 | 15.5 | 15.5 | 14.5 | 15.0 |
| Grain-unit, g/l, no less than | 600 | 570 | unlimited | unlimited | |
| Mass of 1000 seed, g, no less than | not regulated | | | 40 | 38 |
| Mass part of protein, %, calculation of absolutely dry matter, no more than | not regulated | | | 11.0 | 11.5 |
| Foreign impurity, %, no more than | 2.0 | 3.0 | 5.0 | 1.0 | 2.0 |
| Especially: | | | | | |
| mineral admixture | 0.3 | 0.5 | 1.0 | 0.5 | 0.5 |
| Especially: | | | | | |
| pebble | 0.1 | 0.1 | 0.5 | 0.1 | 0.1 |
| slag, ore | 0.05 | 0.05 | 0.1 | 0.05 | 0.05 |
| spoiled grain | 0.2 | Within the foreign material | | | |
| wild oat | 1.0 | Within the foreign material | | | |
| darnel | 0.3 | 0.3 | 0.5 | 0.3 | 0.3 |
| Especially: | | | | | |
| fuzarious grain | 1.0 | 1.0 | 1.0 | not permitted | |
| harmful admixture | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Especially: | | | | | |
| smut, ergot | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Trichodesma incanum | 0.05 | Within the harmful impurities | | | |
| heliotrope | not permitted | | | | |
| Grain admixture, %, no more than | 7.0 | 3.0 | 15.0 | 2.0 | 5.0 |

Appendix 8. Continued

| | | | | | |
|--|---|----------------------------|---------------|-----|-----|
| Especially: | | | | | |
| the grain of barley, grain admixtures | 2.0 | Within the grain admixture | | | |
| sprout grain | 2.0 | Within the grain admixture | | | |
| grain and seeds of other crops, grain admixtures | 3.0 | Within the grain admixture | | | |
| including: | | | | | |
| grain of rye and oats | 5.0 | Within the grain admixture | | | |
| Small-sized seeds, % no more than | 5.0 | 5.0 | unlimited | 5.0 | 7.0 |
| Largest, %, no less than | not regulated | | | 85 | 70 |
| Ability to germination, %, no less than | not regulated | 92 | not regulated | 95 | 92 |
| Vital capacity, %, no less than | not regulated | 92 | not regulated | 95 | 95 |
| Damage by insects | not permitted except infestation by the ticks of 1-t degree | | | | |

**Norms of natural losses of fruit and vegetable products
and potato at the prolonged storage, %**

| Production | Type depository for storage of fruits | September | October | November | December | January | February | March | April | May | June | July | August |
|--------------------|---------------------------------------|-----------|---------|----------|----------|---------|----------|-------|-------|-----|------|------|--------|
| <i>Cold Zone *</i> | | | | | | | | | | | | | |
| Apples: autumn | Coolers | 1.2 | 0.8 | 0.6 | 0.5 | 0.5 | 0.4 | - | - | - | - | - | - |
| | Without the artificial cooling | 2.0 | 1.2 | 1.2 | 1.0 | 1.0 | - | - | - | - | - | - | - |
| winter | Coolers | 1.0 | 0.4 | 0.3 | 0.3 | 0.25 | 0.25 | 0.3 | 0.3 | 0.3 | 0.5 | - | - |
| | Without the artificial cooling | 1.8 | 0.8 | 0.6 | 0.5 | 0.5 | 0.5 | - | - | - | - | - | - |
| Pears | Coolers | 1.0 | 0.8 | 0.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | - | - | - |
| | Without the artificial cooling | 2.0 | 1.5 | 1.4 | 0.7 | 0.6 | 0.6 | - | - | - | - | - | - |
| Grapes | Coolers | 1.0 | 0.8 | 0.8 | 0.6 | 0.4 | 0.4 | 0.4 | - | - | - | - | - |
| Cranberry | Warehouses and canopy | - | - | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 1.5 | 2.0 | 4.0 | 5.0 | - |
| Cowberry | Warehouses and canopy | 5.0 | - | - | - | - | - | - | - | - | - | - | 3.0 |
| <i>Warm Zone *</i> | | | | | | | | | | | | | |
| Apples: autumn | Coolers | 1.2 | 0.8 | 0.6 | 0.5 | 0.5 | 0.4 | - | - | - | - | - | - |
| | winter | « | 1.0 | 0.4 | 0.3 | 0.3 | 0.25 | 0.25 | 0.3 | 0.3 | 0.5 | 0.5 | - |
| Pears | « | 1.0 | 0.8 | 0.6 | 0.6 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | - | - | - |
| Grapes | Warehouses without artificial cooling | 1.5 | 1.2 | 1.2 | 0.9 | 0.8 | 0.8 | - | - | - | - | - | - |
| | Coolers | 1.0 | 0.8 | 0.8 | 0.6 | 0.4 | 0.4 | 0.4 | - | - | - | - | - |
| Cranberry | Warehouses without artificial cooling | - | - | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.7 | - | - | - | - |

* The warm zone includes Crimea, Mykolaiv, Kherson, Odessa region, the cold - other regions of Ukraine.

| Production | Type of depository | September | October | November | December | January | February | March | April | May | June | July | August | |
|--|--|--------------------------------|---------|----------|----------|---------|----------|-------|-------|-----|------|------|--------|---|
| <i>Cold Zone*</i> | | | | | | | | | | | | | | |
| Beets, radish, rutabaga, kohlrabi, parsnip | With the artificial cooling | 1,5 | 0,8 | 0,8 | 0,7 | 0,6 | 0,6 | 0,6 | 0,8 | 0,9 | 0,9 | - | - | |
| | Without the artificial cooling | 1,7 | 0,9 | 0,8 | 0,7 | 0,6 | 0,6 | 0,6 | 0,8 | 1,1 | 1,9 | - | - | |
| | Clamps, trenches | 1,5 | 1,0 | 0,7 | 0,6 | 0,2 | 0,3 | 0,6 | 0,9 | 2,0 | - | - | - | |
| Carrot, parsley, celery, turnip | With the artificial cooling | 2,2 | 1,3 | 1,2 | 0,8 | 0,7 | 0,7 | 0,7 | 1,0 | 1,0 | 1,0 | - | - | |
| | Without the artificial cooling | 2,3 | 2,0 | 1,3 | 0,8 | 0,7 | 0,8 | 1,0 | 1,2 | 1,4 | - | - | - | |
| | Clamps, trench with the mixing of sand | 1,2 | 1,0 | 0,6 | 0,4 | 0,3 | 0,4 | 0,4 | 0,6 | 1,2 | - | - | - | |
| White cabbage, Red, Savoy, russels grades: | Clamps, Trenches** | 1,5 | 1,3 | 1,2 | 0,6 | 0,6 | 0,6 | 0,8 | 0,9 | 2,0 | - | - | - | |
| | Average maturity | Without the artificial cooling | - | 3,3 | 2,4 | 1,1 | 2,5 | 2,7 | - | - | - | - | - | - |
| | | Clamps, trenches | - | 3,3 | 1,8 | 1,0 | 2,0 | 2,5 | - | - | - | - | - | - |
| Late maturity | With the artificial cooling | - | 2,3 | 1,3 | 1,0 | 1,0 | 1,0 | 1,0 | 1,3 | 1,8 | 1,8 | - | - | |
| | Without the artificial cooling | - | 2,8 | 2,1 | 1,0 | 1,0 | 1,2 | 1,3 | 1,5 | - | - | - | - | |
| Onion-Ripky and sample food | Clamps, trenches | - | 2,8 | 1,8 | 0,8 | 0,8 | 0,8 | 1,1 | 1,3 | - | - | - | - | |
| | With the artificial cooling | 0,8 | 0,7 | 0,6 | 0,5 | 0,5 | 0,5 | 0,6 | 0,8 | 1,1 | 1,2 | 1,5 | 1,5 | |
| Garlic | Without the artificial cooling | 1,7 | 1,2 | 1,1 | 0,6 | 0,6 | 0,6 | 0,6 | 1,0 | 1,7 | - | - | 2,5 | |
| | With the artificial cooling | 1,6 | 1,0 | 0,9 | 0,9 | 0,9 | 0,9 | 0,9 | 0,9 | 1,5 | 1,5 | 1,5 | 1,7 | |
| Pumpkins | Without the artificial cooling | 3,0 | 2,0 | 1,2 | 1,1 | 1,1 | 1,2 | 1,3 | 1,5 | - | - | - | - | |
| | With the artificial cooling | 1,5 | 1,2 | 0,7 | 0,5 | 0,3 | - | - | - | - | - | - | - | |
| Potato | Specialized store | 1,4 | 1,2 | 0,8 | 0,6 | 0,5 | 0,5 | 0,5 | 0,9 | 1,1 | - | - | - | |
| | Clamps, trenches | 1,4 | 1,0 | 0,7 | 0,4 | 0,4 | 0,4 | 0,7 | 0,9 | 1,5 | - | - | - | |

Appendix 9. Continued

| | | <i>Warm Zone</i> | | | | | | | | | | | |
|---|--------------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Beets, radish, rutabaga, kohlrabi, parsnip | With the artificial cooling | 1,6 | 1,1 | 1,0 | 0,7 | 0,6 | 0,7 | 1,1 | 1,1 | 1,1 | 1,2 | - | - |
| | Without the artificial cooling | 2,0 | 1,3 | 1,0 | 0,7 | 0,6 | 0,7 | 1,2 | 1,8 | 1,9 | 2,0 | - | - |
| | Clamps, trenches | - | 1,5 | 1,3 | 0,7 | 0,5 | 0,6 | 0,7 | 2,3 | 2,5 | - | - | - |
| Carrots, parsley, celery, turnip | With the artificial cooling | 2,3 | 1,8 | 1,3 | 0,8 | 0,7 | 1,3 | 1,4 | 1,6 | 1,8 | 1,9 | - | - |
| | Without the artificial cooling | 2,5 | 2,2 | 1,3 | 0,8 | 0,7 | 1,3 | 1,6 | 2,3 | 2,5 | - | - | - |
| White cabbage, Red, Savoy, Brussels grades: | | | | | | | | | | | | | |
| | Average maturity | | | | | | | | | | | | |
| | Without the artificial cooling | - | 4,0 | 3,8 | 2,3 | - | - | - | - | - | - | - | - |
| | Clamps, trenches | - | 3,5 | 2,3 | 1,8 | 1,3 | 1,3 | 2,0 | - | - | - | - | - |
| | Late maturity | | | | | | | | | | | | |
| | Without the artificial cooling | - | 3,8 | 3,5 | 2,0 | 1,4 | 1,4 | 2,1 | - | - | - | - | - |
| | Clamps, trenches | - | 3,8 | - | - | - | - | - | - | - | - | - | - |
| Onion-Ripky and sample food | With the artificial cooling | 0,8 | 0,7 | 0,6 | 0,5 | 0,5 | 0,5 | 1,0 | 1,3 | 1,6 | 1,6 | 1,8 | 1,8 |
| | Without the artificial cooling | 2,0 | 1,5 | 1,3 | 0,7 | 0,6 | 0,7 | 1,1 | 1,6 | 2,0 | - | - | 3,0 |
| Garlic | With the artificial cooling | 1,9 | 1,7 | 1,2 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,7 | 1,7 | 1,7 | 2,0 |
| | Without the artificial cooling | 3,2 | 2,1 | 1,5 | 1,1 | 1,1 | 1,2 | 2,0 | 2,5 | - | - | - | - |
| Pumpkins | With the artificial cooling | 1,5 | 1,2 | 0,7 | 0,5 | 0,3 | 0,3 | - | - | - | - | - | - |

*In the cool zone the storage of products without artificial cooling set losses at specific norms are established for depositories with artificial cooling.

** When root crops are stored in the trenches and tabular heaps of mixed sand specific losses are not determined, with cold storage with controlled environment such losses are calculated using the rules of storage of cooled minus 15 %.

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