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S. Sots¹, PhD of tech. science, associate professor, E-mail: sotsereg@gmail.com
I. Kustov¹, PhD of tech. science, assistant, E-mail: i.kustov1988@gmail.com
Y. Kuzmenko¹, PhD of tech. science, assistant, E-mail: kuzmenko.y89@gmail.com
O. Vereshchynskyi², Dr. of tech. science, director

¹Odessa National Academy of Food Technologies, 112, Kanatna Str., Odessa, 65039, Ukraine

²LLC "OLIS", Odessa, Ukraine

FEATURES OF PROCESSING OATS INTO GROATS PRODUCTS

Abstract

In the given article the existing technologies of hulled oats grain processing into groats products were analyzed. The possibilities of using new breeding varieties of oats to improve existing technologies were analyzed. Advantages using naked oat varieties for the production of groats and flakes were considered. Results of research influence intensity of pearling and water heat treatment on yield of pearled groats and its quality indicators were shown. The high efficiency of use naked oats for the production of pearled groats with regulated quality indicators was determined. It was found that the technologically expedient moisture content of naked oats before pearling is 12-12.5 %. In the pearling the grain with this humidity depending on the duration of pearling yield of groat estimated to range between 78-94 %. Use as raw materials naked oats increase yield of pearled groats at 1.4-1.6 times in compared to processing of conventional varieties.

Modes of preparation of pearled groats for flaking was investigated, feature their influence on the yield and qualities of flaked groats were determined. Analyses of the physical properties of the obtained flaked products were conducted. It was found that the technologically expedient moisture content of pearled naked oats groats before steaming is 17-17.5 %. After steaming groats with this moisture yield of flaked groat estimated to range between 84,3-93,6 %. The main stages of processing naked oats into groats products were determined. The technological scheme of processing naked oats for producing groats and flakes were developed. The technological scheme of processing hull-less barley and naked oats for producing groats, flakes, mixtures of groats and flakes were developed. Technology includes grain cleaning stage, grain water heat treatment, pearling, sorting of pearling products, pearled groat water heat treatment, mixing, flaking, drying, and control of end products.

Key words: naked oats, groats, flakes, pearling, water-heat treatment, steaming, flaking, modes of processing, scheme of processing, chemical composition.

Introduction

In present conditions groat industry refers to the socially significant sectors of agricultural complex. The condition and its development is one of the determining factors of well-being working capacity and health of the population. For many centuries oats grain were important fodder and food crops and the beginning of the twentieth century observed growth in its use in agricultural production and processing industry.

Is widely distributed products of processing of oats in different countries are groats, flakes, flour and food bran, apart from traditional products producing instant groats, muesli, different purpose semifinished products. Oat is also widely used in other areas of manufacturing industry: its additionally use in the production of beer, oat milk, the ice cream, bread, cookies, baby food, and others.

Standard products of processing oats in Ukraine are not crushed oats groat of which during further processing produces flaked groats, flakes "Hercules", "Pelyustkovi". Separate oat products are flakes "Extra" and "Tolokno" – special prepared oats flour [1].

Not crushed oats groats are products derived from whole kernel they are divided into grades by quantitative content of benign and crushed kernel and presence in the product not hulled grain. Flaked groats and all kinds of oats flakes through the passage during their pro-

ducing additional special treatment can be referred to the instant foods. Numbers of flakes "Extra" proportional to the size and shape of previously prepared raw materials due to what they have a high uniformity which is provided by passage and overtail of defined number of sieve. "Tolokno" by its properties are very important food product. As stand-alone product "Tolokno" widely used in dietary nutrition. "Tolokno" and different kinds of oat flour due to the absence of gluten as separate products is almost not applicable but in mixtures with wheat flour oats flour widely used in the baking industry in the production of bread bakery and confectionery products and as in improver in other areas of food processing industry. The technological processes of processing oats are amongst the most difficult in cereal production and the need for large production areas for its implementation [2].

For example in the production of not crushed oats groats cleanup of impurities, divided into two factions and specially prepared oats grain enters operational silos passes magnetic control and goes to dehulling stage which carried out on two systems separately for each faction. Modes of dehullers set so that provide a minimum amount of crushed groats at the maximum value of the dehulling coefficient on the first dehulling system. After each dehulling system carried out sorting of dehulling products using the groats separation stage.



First at sieving machine (usually use dressing reel) use sieves \varnothing 2,0 mm removing husking bran then on the two systems of aspirators removed hulls and remainder of husking bran. Mixture of dehulling products which consists of dehulled and unde-hulled crops sent to groats separation stage which is carried out on paddy separators.

The classic scheme provides two sequential passages of these machines. Overflow from first Paddy machine represents unde-hulled crops which are sent for second dehulling system, underflow – dehulled crops control on second paddy separator and then sent to pearling.

Pearling conducted on one system. Usually, at this stage are used pearlier machines. Also allowed the possibility of exclusion from the technological scheme if dehulling conducted at hulling stone and air transport is used to transport products of processing. Under these conditions, more intensive processing of grain at hulling stone and friction in the walls of products pipe line provide a similar surface treatment as the pearling system.

After pearling are carried sorting products, which are formed at this stage. From the mixture remove husking bran, particles of crushed groat and small amount of hulls. Sorting of pearling products is carried out at plansifter.

Overflow from sieve 2,5x20 mm referred to feed impurities, underflow of sieve \varnothing 2,0 mm removed a mixture of crushed kernels and husking bran. Oats groat obtains by underflow of sieve 2,5x20 mm. End product for control passed through two control systems of paddy separator and then controlling in one system of air separators.

In applying the classical scheme provides the production of high, first and second grades of groats, the total yield of finished products is 45-55 % [3].

Oats are the raw material for the production of a wide range of flaked products. From it produce flaked groats, flakes "Hercules", "Pelyustkovi" and "Extra". For all types of flakes as raw material allowed using oats groats or oats grain. Each type of flakes has its production technological features.

For the production of flaked oat groats are used high or first grade of oats groat. In the first stage groats sent to water heat treatment which consists in its steaming at horizontal screw steamer with the vapor pressure 0,05-0,10 MPa.

Steamed groats temper in special insulated bins for 20-30 min. Flaking of groats allowed to carry on flaking machine or roller mills with ribbed rollers. Thickness of flakes typically is 0.7-0.9 mm.

Flaked groats sent to sorting, during which by underflow of sieve \varnothing 2,0 mm conduct removing of husking bran and particles of crushed groats, by overflow from this sieve obtain flaked groats which controlling by passed through two control systems of air separators.

For the production of flakes "Hercules" is used high grade of oats groat. The classical scheme includes the following steps: steaming, tempering, flaking, sorting and cooling of end products.

At the beginning of the technological process carried out additional control of groats at two consecutive systems of paddy machines and one system of groats separation. At systems of paddy machines remove unpro-

cessed grain which return to dehulling systems or if plant does not have the conditions for it processing sent to waste products.

Control of husking bran and crushed groats conduct at groats separation machines. By overflow from sieve 2,5x20 mm obtain groats which sent for further processing.

Water heat treatment in the production of flakes "Hercules" carried out a similar scheme and modes which provides for the production of flaked groats. Flaking stage carry on flaking machine with smooth rollers, thickness of flakes typically is 0.6 mm.

Obtained flakes are dried at belt dryer to standardized humidity 12,0 % and control at two control systems of air separators. For the production of flakes "Pelyustkovi" is used high or first grade of oats groat. At the beginning of the technological process carried out additional control of groats which carried similarly of the process of production flakes "Hercules" and then groats additionally send to one pearling system.

Surface treatment of groats reduces the content of mineral elements to 1.9 % which is regulated by standard. The mixture of pearling products at first sorts at dressing reel where by underflow of sieve № 080 remove husking bran, after this at groats separation machine remove crushed kernels and separates groats into two factions which sent to control at air separators systems. Next stages: water heat treatment, flaking, drying and control operations carried similarly of the process of production flakes "Hercules"[4].

Analyzing the classical technology of processing oats in groats and flakes it can be concluded that they are outdated, contain large amounts of energy-intensive operations after which get a low yield of groats and flakes. Almost half of all refined products consists waste products (up 46 %) In modern conditions carrying out such a complex technological process with low yield of finished products is unprofitable.

Increased food use oats and increase the yield and quality of groats and flakes possible when used in the technological process oat varieties with improved technological properties and chemical composition. Using modern breeding varieties of oats for food production will reduce the number technological operations and the length of technological process that will allow getting increased yield and high quality of products.

Naked oats grain is valuable crop that has high nutritional value and due to its chemical composition is used in different sectors of the world industries. The advantage of naked forms of oats is almost total absence of hard floral hulls, which are firmly related to the surface of the grain (20...40 % in hulled oats forms) which greatly improve their technological properties. Naked oats grain has thin and papery hulls which are practically completely separated in the process of harvesting and thrashing of the grain.

In Ukraine naked oats grain is a relatively new culture which is not widely used for production of groats products. Existing recommendations do not include features of technological properties, presence of hulled grain, and chemical composition [5].



Material and methods

The promising and the most common samples of naked oats cultivar «Salomon» cultivated in Ukraine in 2013...2017 years were used for researches.

Before pearling stage samples of naked oats moistening to 12 and 14 %, then tempering 3-5 hrs. Pearling was carried out in the laboratory dehulling and pearling which used method of intensive abrasion. Samples of naked oats grain pearled for 30 to 300 s with the change interval 30 s. Samples of pearled groats were moistening to 15, 17 and 19 % and then tempering for 2.5-3.0 hrs.

Steaming of groats were carried out in the laboratory steamer of periodic action VK-30. Specially prepared sample of the studied material was filled in the special cartridge and placed in steamer. With help of the intake and exhaust valves the pressure and time of steaming were regulated. Groats was steamed at 0,10, 0.15 and 0.20 MPa for 60 to 300 s with the change interval 60 seconds and then sent to the flaking stage.

Flaking was carried out in the laboratory mill «Nagema» which includes a roller mill with two pairs of rollers 150 mm length and 220 mm in diameter. Working gap set 0.3-0.5 mm.

Drying of flaked groats were carried out in the laboratory dryer which works on a "fluidized bed". Mode of operation of the dryer (degree of removal of excessive moisture) was regulated by temperature changes drying agent (air) and time of the flakes location in the working area of the dryer. Flakes were dried to a moisture content of 14 %.

Protein content of grain was determined according to the method GOST 10846-91, fat content was determined according to the method GOST 29033-91, starch content of the samples was determined according to the method GOST 10845-98, ash content according to the method GOST 10847-74.

Results and discussion

The results of research of influence intensity of pearling naked oats with different moisture content on yield of groats are presented in figure 1.

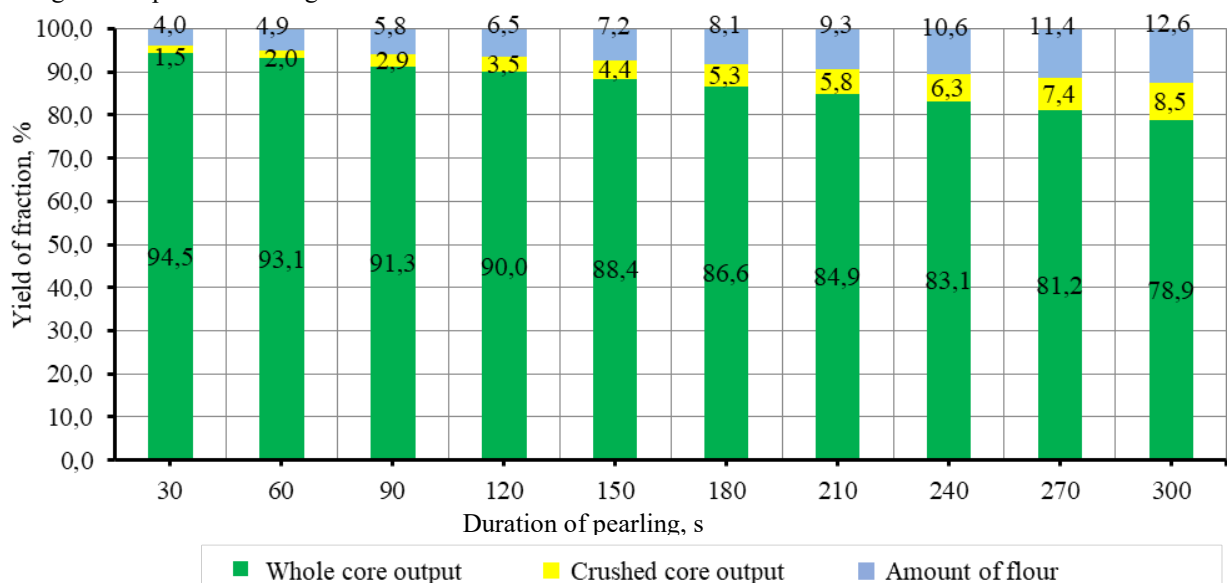


Fig. 1 – Changing yield of groats, particles of crushed groats and husking bran by pearling oats grain with moisture content of 12.5 %

It was found that the technologically expedient moisture content of naked oats before pearling is 12-12.5 %. In the pearling the grain with this humidity depending on the duration of pearling yield of groats estimated to range between 78-94 %. Increasing moisture content of grain before pearling to 14 % does not significantly change the limits of yield values, and pearling grain with low moisture content of 10.5% leads to excessive grinding and formation of a significant amount of by-products and waste in the form of fine particles and husking bran. Use as raw materials naked oats increase yield of pearled groats at 1.4-1.6 times in compared to processing of conventional varieties.

Providing rational management of processing of naked oats is possible, provided that the mass fraction of ash in pearled groats at the level of regulated (to produce flakes) 1,9-2,1% which will allow for further processing of this groats into flakes without use of additional operations in the technological process for example additional pearling stage. In the application of the existing scheme, application of dehulling and pearling stages due to the removal of rich in minerals upper layers of the grain mass fraction of ash in the grain decreases from 3.2 to 2.1%. Mass fraction of ash in the control groats include 1,7-2,0 %. By pearling of naked oats mass fraction of ash decreases from 2.4 to 2.2-1.2 %.

Starch in oats kernel is predominant component of carbohydrate complex its main quantity is placed in the endosperm. During dehulling and pearling oats in classical groats in relation to grain increased mass fraction of endosperm due to which mass fraction of starch increased from 53.7 to 58.2 in groats. Mass fraction of starch in the control groats include 59,7 – 61,7 %.

Depending on initial parameters of pearling (humidity and duration) in groats due to removal of bran parts and aleurone layer has been gradually increasing in mass fraction of starch from 60 to 67 % (figure 4). Pearling of grain during 60-180 s allows produce groats with a mass fraction of starch from 61 to 64 % A high level of starch in the kernel indicates the necessity of intensive pearling of grain to provide the necessary limits of regulated ash mass fraction of 1.9 2.1%.

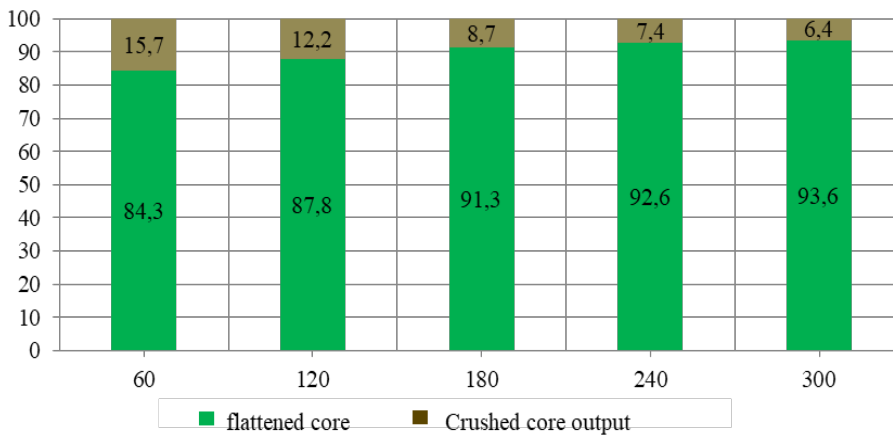


Fig. 2 – Influence of modes of water heat treatment and steaming on yield of flaked groats, $P=0,15$ MPa, $W=17,5$ %

Mass fraction of β -glucans in the control groats include 3,7-4,6 %. Depending on initial parameters of pearling (humidity and duration) in groats due to removal of parts of aleurone layer has been gradually reduction in mass fraction of β -glucans from 7 to 3 % (figure 5). Pearling of grain during 60-150 s allows produce groats with a mass fraction of β -glucans from 5.9 to 6.7 % what more on 2,1-2,2 % compared with a control sample. Processing of naked oats in the indicated mode of pearling allows producing pearled groats with a high content of soluble fiber, which gives it the dietary properties.

At the next stage modes of preparation of pearled groats for flaking was investigated. To ensure high effectiveness of use raw materials at the production of flakes is necessary to provide combined method of water heat treatment. For substantiation of processing modes of pearled groats from naked oats into flakes necessary to determine the effect modes of water heat treatment on yield and quality of flaked products.

The results of research of influence intensity of water heat treatment modes and steaming on yield of flaked groat are presented figure 1.

It was found that the technologically expedient moisture content of pearled naked oats groats before steaming is 17-17,5 %. After steaming groats with this moisture yield of flaked groat estimated to range between 84,3-93,6 %. According to the preliminary organoleptic assessment flaked product obtained by this mode described as flakes.

Decreasing moisture content of pearled groat to 15,4 % does not allow to change of physico-chemical and technological properties in full volume which is indicated by significant amount of husking ban which formed by flaking. Significant amount of husking ban indicates insufficient plastic properties of pearled groats. In addition, by flaking of pearled groats prepared at this mode from flakes breaking away parts and the end product is characterized by asymmetric shape. Increasing humidity to 19,1% allows increasing the yield of flaked groats however excessive humidity of groats before steaming results in strengthening of groats and losses of its plastic properties so flakes obtained in this mode for organoleptic assessment and character the surface are flaked groats.

In the application of the recommended modes of preparing pearled groats to flaking yield of flaked prod-

ucts at 1.7-1.9 times higher than yield of flakes obtained from hulled oat which indicates the high potential of investigated naked oats variety "Salomon" for the production of cereal flakes.

For substantiation of modes of preparing pearled groats to flaking determining of its impact on physical properties of the flaked groats were conducted. Quality of oat flakes except nutritional value, also evaluate by physical properties which include geometric characteristics and strength [7].

The strength and thickness are interrelated parameters - flakes with less thickness are usually characterized by low strength and at different stages of technological process are able to destruction that increases proportion of husking bran and reduces the nutritional value of the product.

Traditionally cereal flakes made from different types of crops characterized by thickness 0,2-1,0 mm. For oats flaked products characteristic values of the thickness is of up to 0.5 mm for flakes "Hercules" and 0.7-0.9 mm for flaked groats. Except thickness, strength of flakes also depends on mass fraction of moisture. For flakes with higher humidity inherent strength is greater compared to a product with low humidity. The final moisture of oat flakes is normalized by regulations and must not exceed 12.0%.

Thickness of obtained in the studied modes flaked products is in the range 0,4-1,1 mm. Flaked products obtained from naked oats by steaming oats groats with moisture content 19,1 % by indicator of thickness characterized as flaked groats for which the characteristic thickness is 0.7 to 0.9 mm. Mode of steaming groats at vapor pressure of 0.15 MPa with moisture content 17,5 % allows producing flaked products which correspond by the value of thickness of the control of classical oat flakes 0,4-0,9 mm. Decreasing moisture content of groats before steaming to 15,4 % allows producing thin flakes, values of thickness of which in the range of 0.4-0.7 mm. At the next stage of research effect of the studied modes of water heat treatment on changing chemical composition of flaked products were determined. The most important components of the chemical composition that formed nutritional value of the product - the mass fraction of ash, protein, starch, fat, β -glucans and vitamins were determined. As a control samples used oats flakes "Super Hercules №1», made by TM "Dobrodija" (Control 1) and flakes "Extra" made by TM "Hercules" (Control 2).

Analysis of literature data shows that depending on the method of treatment and appointment ash values in oat flakes may vary in the range of 1.54 to 2.03%. In our country, according to current regulations indicator of ash content of traditional oat flakes "Hercules" and "Pelyustkovi» is guarantee and depending on product limited and is not more than 1.9% for "Pelyustkovi» and

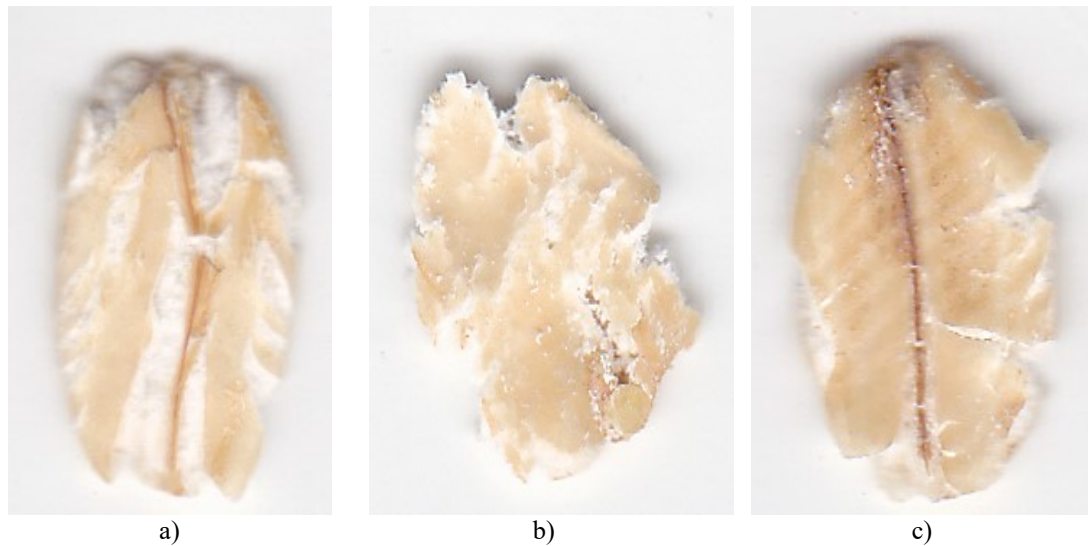


Fig. 3 – View of the flaked product obtained by:
a) $W=17,5\%$, $P=0,15\text{ MPa}$, $t=180\text{ s}$; b) $W=15\%$, $P=0,15\text{ MPa}$, $t=180\text{ s}$; c) $W=19,1\%$, $P=0,15\text{ MPa}$, $t=180\text{ s}$

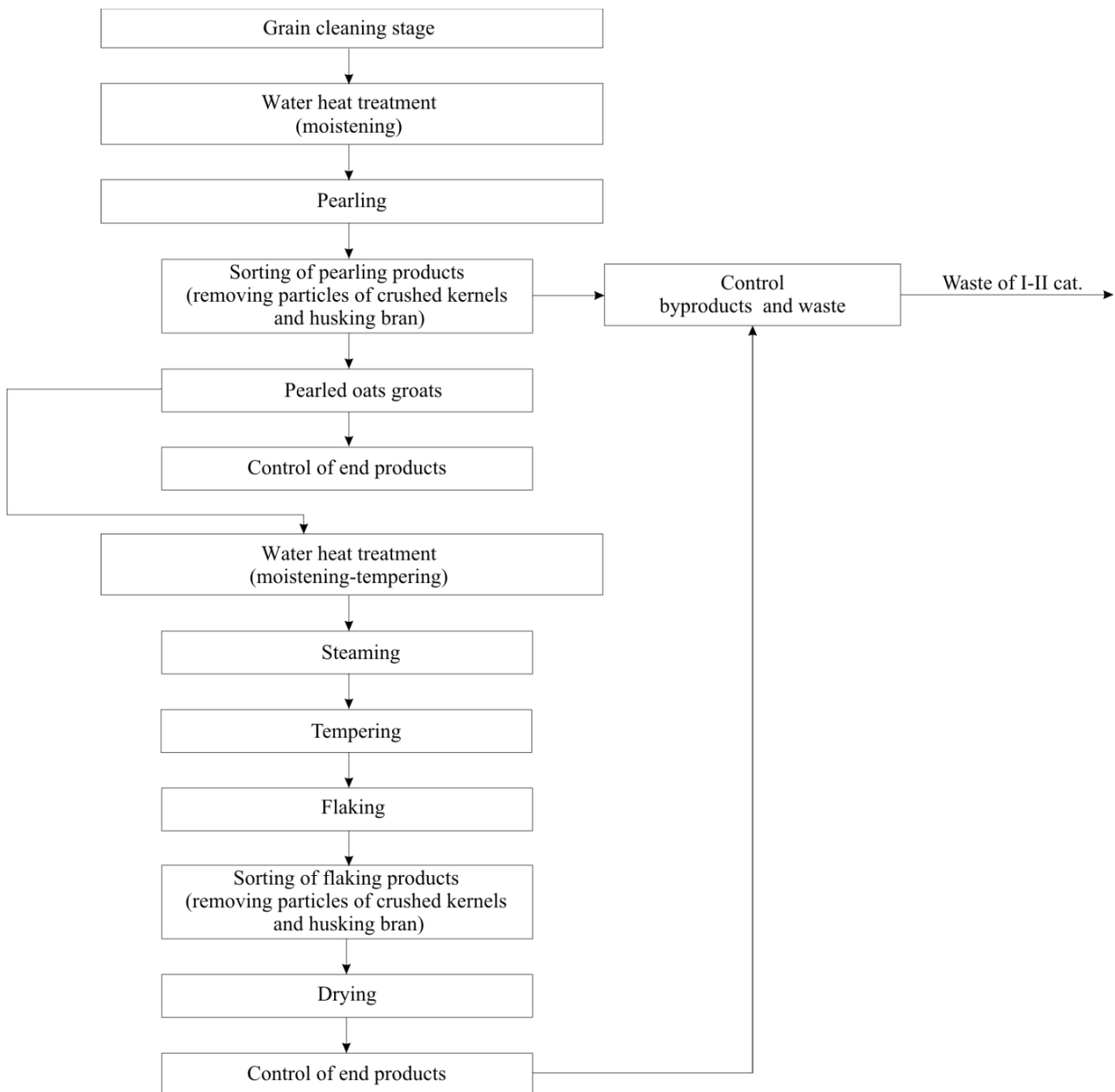


Fig. 4 – Structure of processing naked oats into groats products



2.1 % for "Hercules". Ash content of classical flakes produced in plant conditions is located in regulated by standard range and include 1,7 % for "Super Hercules №1» and 1.8 % for flakes "Extra".

Water heat treatment of pearled groats with further its flaking reduces the proportion of ashes of flaked products from 1.8 to 1.5%. The ash content of samples obtained by flaking pearled groats with initial moisture content 17% and 19 steamed with vapor pressure of 0.15 MPa include 1.6-1.8% which is located within values of ash in classical flakes therefore the use of these modes of steaming allows to produce flakes from naked oats with mass fraction of ash which regulated by standard [8].

By this mode of preparation pearled groats to flaking mass fraction of protein in flaked products include 11,7- 13,2% fat - 6,0-6,3% starch - from 58-62%, β -glucans - 5,1-5,7%, vitamin B1 - 0,52-0,55 mg / 100 g B2 - 0,12-0,15 mg / 100 g. Defined mode of processing allows producing flaked products during further processing of pearled groats which are characterized by regulated ash content and by content of other biologically active substances match to traditional products made from hulled grains.

Based on the data structure of processing naked oats into pearled groats and flaked products was developed which includes grain cleaning stage, grain water heat treatment, pearling, sorting of pearling products, pearled groat water heat treatment, flaking, sorting of flaking products and drying [9].

The features of the developed scheme are lack in technological process of energy-intensive complex operations of grain steaming, drying, dehulling, sorting of dehulling products, groats separation stage, control of groats into paddy separators and groat separators before processing into flakes[10].

Grain cleaning stage carried out by existing schemes by using traditional grain cleaning equipment: separator classifier, magnetic separator, destoner,

plansifter, trieur and possible inclusion in process paddy separators.

For grain moisture content of which smaller than 12-13% to improve efficiency following stages of pearling and increase yield provided water heat treatment method of cold conditioning.

Pearling stage of naked oats grain carried at pearliers in which method of intensive abrasion is realized. Effectiveness of pearling is estimated by yield of husking bran amount of which is determined depending on the produced product.

As a result of pearling of naked oats grain formed a mixture consisting of whole pearled groats, particles of crushed kernels and husking bran. For its separation and removal of whole pearled groats the mixture at the first stage is sent to plansifter where conduct removal of particles of crushed kernels and husking bran. Whole pearled groats additional control to the residues of husking bran by passage of through a system of air separators [11].

For the production of flaked products, pearled groats moisturize with moisturizing machines, tempering and sent to steaming. Steamed groat tempering and after this sent to flaking. Mixture of flaking products is sorted at plansifter and drying in belt driers.

Conclusion

It is proved the high effectiveness of using naked oats as raw material for production groats products with regulated quality indicators. The features of the developed scheme are lack in technological process of energy-intensive complex operations of grain steaming, drying, dehulling, sorting of dehulling products, groats separation stage, control of groats into paddy separators and groat separators before processing into flakes. Use as raw materials of naked oats at the recommended modes can increase yield of pearled and flaked groats at 1.5-1.7 times in compared to processing of conventional varieties.

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С.М. Соц, канд. техн. наук, доцент, E-mail: sotssserega@gmail.com
І.О. Кустов, канд. техн. наук, ст. викладач, E-mail: i.kustov1988@gmail.com
Ю.Я. Кузьменко, канд. техн. наук, асистент E-mail: kuzmenko.y89@gmail.com
О.П. Верещинський, д-р техн. наук, директор

¹Одеська національна академія харчових технологій, вул. Канатна, 112, Одеса, 65039, Україна
²ТОВ «ОЛІС», Одеса, Україна

ОСОБЛИВОСТІ ПЕРЕРБКИ ЗЕРНА ВІВСА У КРУП'ЯНІ ПРОДУКТИ

Анотація

В даній статті проаналізовані існуючі технології переробки зерна вівса у крупу. Були проаналізовані можливості використання нових сортів вівса для вдосконалення існуючих технологій. Розглянуто переваги використання голозерних сортів вівса для виробництва круп та пластівців. Наведено результати дослідження впливу інтенсивності пошкодженого зерна і водної термічної обробки на отримання перлової крупи та її якісні показники. Встановлено високу ефективність використання голозерного вівса для виробництва крупи перлової з регульованими якісними показниками. Було встановлено, що технологічно доцільний вміст вологи у голозерному вівсі перед переробкою становить 12-12,5%. У зерна з такою вологістю в залежності від тривалості переробки вихід круп оцінюється в діапазоні від 78 до 94%. Використання в якості сировини голозерного вівса підвищує вихід перлової крупи в 1,4-1,6 рази в порівнянні з переробкою звичайних сортів.

Досліджено режими приготування перлової крупи до відшарування, визначено особливості їх впливу на вихід і якість крупи. Був проведений аналіз фізичних властивостей отриманих продуктів подібних пластівцям. Було встановлено, що технологічно доцільний вміст вологи у крупі з голозерного вівса до пропарювання складає 17-17,5%. Після пропарювання крупи з такою вологістю вихід крупи оцінюється в діапазоні від 84,3 до 93,6%. Визначено основні етапи переробки голозерного вівса в круп'яну продукцію. Розроблено технологічну схему переробки голозерного вівса для виробництва круп і пластівців. Технологія включає очищення, воднотеплову обробку, шліфування, сортування продуктів шліфування, воднотеплову обробку шліфованого ядра, змішування, плющення, сушіння та контроль готової продукції. Завдяки відмінностям у характеристиках, особливо у формі зерна, первинна обробка голозерного вівса та голозерного ячменю проводиться без етапу фракціонування на двох паралельних технологічних лініях.

Ключові слова: голозерний овес, крупа, пластівці, пошкоджене зерно, водна термічна обробка, пропарювання, луцення, режими переробки, схема переробки, хімічний склад.

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