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Conformity assessment of information on crushing equipment for agricultural raw materials: consequences of the lack of appropriate standards

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Abstract. The paper reviews the analysis of information about hammer (rotary) crushers for the production of compound feedstuff. It is shown that for the majority of crushers studied, the information is incomplete or unreliable, which is misleading for consumers purchasing this equipment. Measures to improve the quality of information on crushing equipment are proposed.

One of the main aspects of the legal regulation of relations between the consumer and the supplier of goods is complete and reliable information that the supplier is obliged to provide, and the consumer has the right to demand. On the basis of the information about the product, the consumer makes the final decision whether to purchase the product or not. The Russian Federal Law “On Protection of the Consumer Rights” [1] gives a detailed list of the information about the product that the supplier is obliged to provide, for example, the designations of standards, the mandatory requirements of for the goods, information on the basic consumer properties of goods, etc.

Consumer properties are disclosed in the process of consumption or exploitation of the goods. They ultimately characterize the quality of the product and are implemented in certain quality indicators. To help to develop a new product or to upgrade the existing one, there are standards of the “System of Product Quality Indicators” series, which are developed based on RD 50-64-84 “Guidelines for the development of state standards that establish a nomenclature of quality indicators for homogeneous product groups” [2].

One of the defining consumer properties, characterizing the ability of goods to satisfy physiological and social needs, is the purpose of the goods. The functional properties determine the use of the product for its intended purpose. Indicators of functional properties characterize the technical nature of products, properties that determine the ability of products to perform their functions in the given conditions of use for the intended purpose.

We will show the consumer properties of the crushing equipment and what information the consumer receives when it is purchased.

One of the main factors affecting the development of the livestock complex, poultry farming, breeding of fur-bearing animals, fish farming and other sectors of the agro-industrial complex, is the state of the compound feedstuff industry. For the successful development of the Russian feedstuff



market a number of target programmes in the field of poultry, pig and cattle breeding have been adopted. The effective implementation of these programmes will allow increasing the production of compound feedstuff by 5 times by 2020.

Preparation of feedstuff is carried out on special equipment. The appearance on the market of small-scale crushing equipment of various purposes and productivity made it possible to organize the manufacture of compound feedstuff directly in small and medium-sized enterprises engaged in the production of meat and dairy products. The economic feasibility of such production is explained as follows: the maximum use is made of its own food supply; transport costs are significantly reduced; it becomes possible to change promptly the compound feedstuff formulation and its daily need. In addition, small feedstuff mills have a lower metal-energy intensity and relatively quick payback. Studies have shown that crushers with a capacity of 1 to 5 t/h are in demand for large farms, and up to 0.5 t/h - for medium and small (private farms) [3].

The grinding product has strict requirements. Grind size is determined by the residue on the screens with holes of 5, 3 and 2 mm. For analysis, a weighed mass of 100 g is taken, sieved on a dissecting analyser for 5 minutes. Residues on the screens are weighed and expressed as a percentage of the hinge taken. The grain size of grinding grain in the production of feedstuff is normalized by national standards: for poultry according to GOST R 51851-2001 [4]; for pigs according to GOST R 52255-2004 [5]; for cattle according to GOST R 52254-2004 [6]. This implies an important consumer property of the crushing equipment - the size of the grinding, which the consumer will receive when operating the purchased equipment.

Naturally, to obtain a smaller crushed fraction requires more effort. Therefore, the consumer should know what the performance of the crushing equipment will be for a given technological process of obtaining the specified sizes of the crushed raw materials.

The choice of grinding method depends on the properties of the material being ground. Raw materials can be crushed by various methods. Hard (brittle) material is most often crushed to particles of a given size by constrained or free impact. Crushing, splitting and breaking are used to obtain lumpy materials and are used, as a rule, in preliminary operations. Cutting and sawing are used when it is necessary to obtain pieces of material of a certain size and a given shape. Abrasion is used for fine grinding, while it is often combined with crushing or impact.

When choosing the principle of grinding, one should be guided mainly by the physical properties of the material being ground and, above all, by its hardness and particle size. All grinding machines must ensure uniform grinding of the product, its rapid removal from the working area of the machine, the ability to control the degree of grinding [7].

Hammer and rotary crushers are mostly used in the technological processes of grinding grain and mineral additives. The principle of their operation is based on dynamic factors i.e. the impact of hammers on the crushed raw materials. In hammer crushers, hammers are hung on the axle, and in rotary crushers, hammers are rigidly attached to the rotor.

Currently, promising grinders of agricultural raw materials are at the stage of research and testing. Their executive mechanism is a special large-module transmission of internal gearing [8, 9]. These shredders are characterized by high energy efficiency and a wide range of processing raw materials.

To identify other consumer properties, an analysis of standards and operational documentation for crushing equipment for agricultural feedstuff was conducted.

Technical requirements for hammer crushers for feedstuff are defined by GOST 28098-89 [10], and the design execution is determined by the developer. At present, hammer crushers with grain productivity from 0.5 t/h to 5 t/h are produced by Russian enterprises LLC NIMOPL "Rodnik" (models: IM-200, IMD-500, IRS-800), OJSC "Kapital-PROK" (model: IMK-200), LLC "New Agrotechnologies" (model DB-5), LLC "Projectservice" (models: DM 500 M, DM 1000, DOS-1, DS-10, DOP-1), etc. One of the well-known suppliers of rotary crushers with a productivity of wheat from 0.5 t/h to 5.2 t/h is LLC "Doza-Agro". They produce the following rotary crusher models: DKR-0.5, DKR-1, DKR-3, DKR-4, DKR-3D and DKR-4D. Similar rotor crushers are produced by LLC SPE "Expro", LLC "Electromotor" and other enterprises.

Hammer and Impact Crushers are widely used abroad. Crushers are produced in series by OJSC “Volkovysk Machine-Building Plant” and LLC “Zapagromash” (Belarus), Talha Tarım, Shti and Atach Helezon, Shti (Turkey), Kovonovak, spolecnost (Czech Republic), Geco Trading Corporation, and Bharath Industrial Works Company, Acemo, S.A.S. (France), Genovese Maquinarias Agrícolas, S.A. (Argentina), Mathews company (USA), LLC “Dozameh” (Ukraine), Shanghai Donglong Heavy (China), etc.

The properties of agricultural raw materials intended for grinding, depend on its type, humidity, and other factors. Hammer and Impact Crushers are high-speed machines that, in the process of work, chop shredded raw materials, i.e., they are intended for grinding only brittle raw materials. Therefore, they have technical limitations on the type and moisture content of the crushed raw materials. Thus we can make the conclusion that the following information should additionally be submitted to the crushing equipment:

- Type of processed raw materials (wheat, oats, barley, etc.);
- Permissible humidity (or humidity range) for each type of processed raw materials;
- Dependence of productivity on the type of raw material and its humidity.

The authors analysed information on crushers of agricultural raw materials put up for sale. Basing on this information, the consumer has to make a choice on the equipment to purchase.

In the course of the research, the information on crushing equipment, taken from the Internet which is accessible to the consumer, was analysed. 69 hammer (rotary) crushers produced both in Russia and abroad were analysed. The information shows grinding performance, electric motor power, overall dimensions and weight. But let us consider what the manufacturer (seller) understands by the word “productivity”. After all, the performance of the same equipment depends on the type of raw material, its moisture content and the diameter of the holes in the sieve (grid). Figure 1 shows the percentage ratio of crushers for which there is information on the impact on the grinding capacity of the type of crushed raw materials, the maximum permissible moisture of the raw materials and the diameter of the holes in the screen (grid) of the crusher. In addition, the authors tried to reveal information about the size and quality of the ground product.

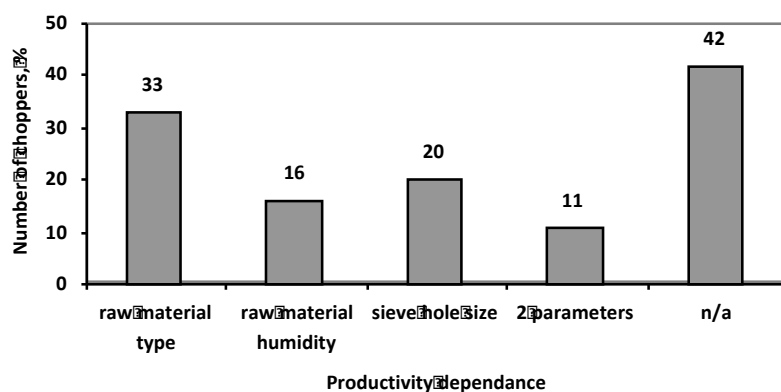


Figure 1. The percentage of crushers having information about the impact on performance of various factors.

Cereals (raw materials for grinding) have different properties that affect the performance of grinding in hammer (rotary) crushers. So rotor crusher DR-2/3, commercially produced by JSC “Plant Technopribor” has the following capacity: in barley - 620 kg/h; for wheat - 560 kg/h; for rye - 400 kg/h; on oats - 300 kg/h. Performance of the hammer crusher DKR-ZMD is 2,800 kg/h for wheat, 2,750 kg/h for rye, 2,500 kg/h for barley, and only 1,850 kg/h for oats.

When grinding such high-yielding and valuable for fattening livestock grains like oats, the performance of hammer crushers drops by 30-50% (figure 2). This is due to the fact that oats are a

composition of a durable shell and a soft core. The shell is not completely destroyed by the blows of hammers, which leads to clogging of the screens (decks) of the crushers.

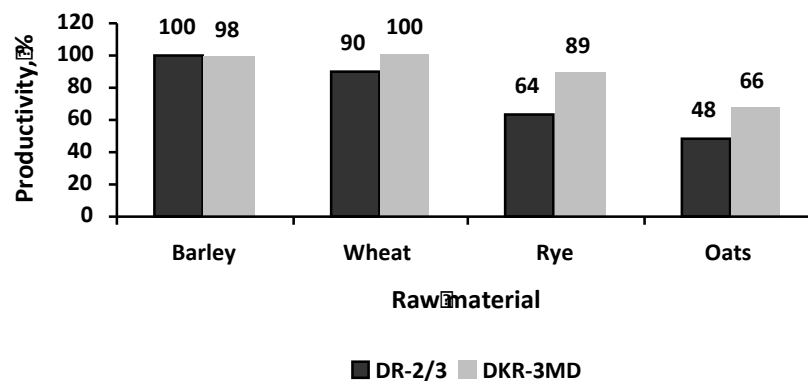


Figure 2. The dependence of the performance of crushers on the type of raw materials.

The analysis showed that only 33% of the crushers under study, in one form or another, link productivity with the type of crushed raw materials. For most crushers, such information for consumers is missing, and only the maximum performance value is given. Therefore, acquiring crushing equipment, the consumer will not be able to achieve the performance stated in the operational documentation for certain types of raw materials.

Let us consider the moisture of the crushed raw materials, which is not only a measure of performance, but also the limit of the operational capabilities of the equipment. While studying the information aimed at the relationship between the performance of crushers and the moisture of the crushed raw materials, it was revealed that only 16% of the crushers under study have information on humidity (figure 1), for example, crusher DB-5 crushes wheat with a humidity of no more than 17% and barley - 12%, IM-200 crusher - no more than 17%, DKR crusher - no more than 14%, etc. The rest of the crushers lack such information, and the moisture of the stock, for example, barley can be 19% (GOST 28672-90 [11]). Consequently, consumers, purchasing a crusher, receive not only incomplete, but also not reliable information.

The grinding degree of the product depends on the size of the sieve holes. The bigger the size of the holes, the larger the crushed product is. Individual crushers provide the grinding capacity depending on the diameter of the holes in the screens. So, for example, hammer-type grain crushers IZEA-01 and IZEA-02 with a bore diameter of 4 mm have a capacity of 90 and 100 kg/h, respectively, and with a bore diameter of 8 mm, they have a capacity of 140 and 150 kg/h, i.e. the diameter of the holes is twice the performance increased by 50%. Let us consider another example. With an increase in the diameter of the holes in the sieve of the hammer crusher DDM-5, the productivity increases by 25%. It is true that the diameter range of the holes is from 5 to 6 mm, which will not allow obtaining a small fraction necessary for the preparation of compound feedstuff for most animals, birds, fish, etc. But even such information is quite rare, only 20% of all the crushers under study have it (figure 1).

Let us return to the fact that for the fattening of various animals, birds, fish, a certain size of compound feed is established according to the relevant standards. Along with technical characteristics, indicators characterizing the quality of products that are manufactured (or planned for release) on this technological equipment are recommended for technological equipment [2]. However, this information is completely absent in the information on crushers on the market. Therefore, manufacturers of crushing equipment disclaim responsibility for the quality of the product produced on crushers. In our opinion, one of the reasons is the lack of a regulatory framework for hammer crushers for equipment quality indicators. As an example, GOST 4.414-86 "System of indicators of product quality. Mills charcoal. The nomenclature of indicators" [12], in which one of the quality indicators established the fineness of grinding. A similar standard for hammer (rotary) crushers is

absent, and GOST 28098-89 [10] establishes certain design requirements and some safety requirements.

Studies have shown that most crushing equipment has the following information:

“The grain crusher DZM-0.8 is intended for the processing of all types of feed grain for fattening all species and age groups of animals and poultry on small livestock farms, rental and farm enterprises.

Technical specifications:

Productivity: up to 1,000 kg/hour; Power: 5.5 kW; Voltage: 380 V; Overall dimensions: 1250x700x1220 mm; Weight: kg 145 kg”.

Of course, such information is not complete and unreliable.

From the analysis we can draw the following conclusions:

1. Crushing equipment must have information about the quality of the product obtained on this equipment, for example, the size of grinding, the permissible amount of impurities, etc. In order to do it, it is necessary to develop a national standard in the framework of the “System of Product Quality Indicators” for hammer (rotary) crushers for agricultural raw materials.

2. It is necessary to redraft GOST 28098-89, which should include the following requirements:

- To the types of processed raw materials;
- To the humidity of the processed raw materials;
- To the quality of the processed product.

3. In manuals the manufacturer has to indicate not only the material to be crushed and its properties, for example, humidity, but also the equipment performance with regard to the material being crushed, its properties and requirements for the size of the diameter of the holes in the sieve (grid) of the crusher. A mandatory requirement is the availability of information about the size of the crushed product, depending on the characteristics of the crusher and the properties of raw materials.

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