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# TECHNICAL CHARACTERISTICS AND CONSTRUCTION FEATURES OF MEAT GRINDERS

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## ABSTRACT

Most of the technological operations for the production of meat products are mechanised and carried out using specially designed equipment, including meat grinders. This paper reviews meat grinders of different design and performance, used in both household and industrial applications. The technical characteristics, construction and operating principle of the meat grinder are described.

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Technical characteristics and construction features of meat grinders: A mini review

## **1** Introduction

For the modern meat-processing enterprises the problem of the further improvement of technological processes and the appropriate equipment for the reduction of its power capacity, losses of raw materials, increase of productivity, improvement of quality of manufactured products is still relevant (Uriev & Taleisnik, 1985). The grinding machines for meat and meat products comprise about half of all operating equipment in meat industry. The most common machine for primary grinding of raw meat is the meat grinder. The meat grinder is designed for grinding meat, which is usually equipped with a special set of cutter plates with different diameters to obtain minced meat of different consistency that is used for different types of semi-finished products (Mustafayeva et al., 2016; Kabulov et al., 2019). The meat grinders are available in floor and table models, and its depending on the design of the meat grinder.

The industrial meat grinder consists of a hopper where the piece of meat is supplied, auger or system of augers and a cutting mechanism which consists of movable knives and fixed plates. The augers transport the meat to the cutting mechanism of the grinder, which is a set of fixed plates and rotating knives. Depending on the purpose of the produced minced meat, the cutter plates are available with a whole diameter varying from 3 to 25 mm, which allows to change the texture of the minced meat (Bakieva et al., 2019). The meat grinders differ in capacity, plate diameter and the processed raw material. Depending on the productivity, meat grinders are divided into three groups viz., household - productivity up to 30 kg/h, catering enterprises - productivity 30-1000 kg/h, and industrial - productivity over 1000 kg/h (Kurochkin & Lyashenko, 2001).

## 2 Determining meat grinder capacity

The meat grinder capacity is calculated by the following formula

(kN):

## $Q{=}F_0{}^*v_0{}^*\rho{}^*\phi$

Where  $F_0$  — total area of holes in the first cutter plate which is closest to the auger,  $m^2$ ;  $v_0$ -the speed of meat moving through the hole of the first cutter plate, m/s;  $\rho$  -product density, kg/m<sup>3</sup>;  $\phi$  — the coefficient of use of the hole area of the first cutter plate ( $\phi$  = 0.7...0.8).

Meanwhile

$$F_0 = \frac{\pi d_0^2}{4} \cdot z_0$$

Where  $d_0$  - hole diameter, m; Zo - number of holes of the cutter plate, pcs. Speed  $v_0$  can be calculated as the speed of nut. Movement relative to the screw along its axis is calculated by the following formula (m/s),

$$v_0 = \frac{\pi n}{60} (r_H + r_B) t g \beta_P K_B$$

Where *n* - auger rotation speed, min-1;  $r_{\rm H}$  and  $r_B$  - the external and internal radii of the last coil of the auger, m, respectively;  $K_B$  - the coefficient of volume supply of the product, which is calculated by the formula:

$$K_B = \frac{\omega - \omega_{\rm np}}{\omega}$$

Where  $\omega$ -auger angular speed, rad /s;  $\omega_{np}$  - product angular speed, rad/s ( $K_B = 0.35...0.4$ ). (Elkhina & Botov, 2010; Muratzhankyzy et al., 2018).

## **3** Features of different meat grinders constructions

Matkin & Sapunkova (2010) proposed the design of an upgraded household electric meat grinder (Figure 1), which includes an



Figure 1 General view of the working body of the modified electric grinder: 1 - clamp; 2 - housing; 3 - spring; 4 - bracket; 5 - second stage plate; 6 - tie ring; 7 - first stage plate; 8 - knife; 9 - cam; 10 - auger; 11 - ring

Journal of Experimental Biology and Agricultural Sciences http://www.jebas.org

electric drive, a working body and a vibrating nozzle. Inside the housing (2) of the meat grinder there is a feed auger (10), which is attached to the motor and receives its rotation. At the output end of the feed auger shaft there is a knife (8) and a fixed plate of the first stage (7). The tight fit of the cutting surface of the knife and the edge of the plate is provided by the tightening ring (6). In the gap between the inner surface of the housing (2) and the blades of the cutting surface of the knife (8) at the output end of the shaft of the auger is installed hardened ring (cam) (9) with an intermittent surface.

The authors of the patent (Patent RU 2479352 C1. 2013) developed a construction of meat grinder. The meat grinder contains a casing with a clamp and a removable handle for screw rotation. The case contains a hollow auger with a movable knife. Inside the screw there is a shaft on one end of which there is an output plate with the possibility of rotation. Between the auger and the shaft is installed kinematic transmission, consisting of several spur gears, main and intermediate, providing rotation of the auger with a movable knife in one direction, and the output plate - in the opposite direction. The handle is designed with the possibility of mounting both on the shaft end and on the shaft of intermediate gears. The invention provides the most favorable modes of grinding, regardless of product hardness.

### 3.1 Meat grinders MIM-300 and MIM-600 (Belarus)

These two are designed for grinding meat and fish for mincing, regrinding of cutlet mass and stuffing sausages at catering enterprises (http://beltorgmash.com/product/myasorubki-mim-300-i-mim-600).

Operation of the meat grinder: The meat grinder consists of an aluminium housing in which the auger rotates a clamping nut, twosided knives, a set of cutter plates, a stop ring and a cutter knife.

The housing is fastened with threaded clamps. Above the filling opening there is a fixed fuse that prevents the operator's hand from getting into the meat grinder auger. Meat or fish is cleaned of bones and cut into pieces not exceeding 0.1 kg. The recommended temperature of the processed product should be  $(8\pm2)$  °C. Connective tissues and tendons are removed from the processed product. The processed product is fed to the neck of the meat grinder body and then pushed towards the rotating auger. The product conveyed by the auger goes through a set of cutting tools. The meat grinder is equipped with a set of cutter plates with holes of different sizes to obtain minced meat of different degrees of cutting. The plates are mounted in the meat grinder body and held back from turning by a cotter pin.

In the working conditions, Akimov et al. (2001) described a construction of the meat-bone grinder. The unit has a body with a

loading hopper. Inside the body there is a screw with variable pitch between coils. The last coil has holes drilled in it. Pre-cut meat is loaded into a hopper, from which it is fed to the chopping bodies by the auger. The pieces of meat, differing in volume and weight, are partially processed with three-blade knives and squeezed out through the plates. A portion of the mass is pressed into the holes and further crushed by the cutting edge, then caught again by the auger coils and fed to the three-blade knives. The machine delivers the product evenly to the shredding bodies, which increases the reliability of its operation.

#### 3.2 The BRIZ Meat Grinder

It is with special auger chamber design with spiral rails and variable auger pitch ensures optimal product consistency and the necessary pressure on the knives for the best cutting conditions even for low-grade meat. The sabre-shaped cutting edge of the knife eliminates impact on the product and, due to the longer cutting length, improves the processing quality. Two steel plates with 4.5 and 7 mm diameter holes ensure the desired consistency of the minced meat. The breakable adapter is the most economical motor protection against the auger jamming (https://www.mobilluck.com.ua/katalog/meat/briz/briz-EMS-30\_160\_M11\_04-108767.html).

## 3.3 The VRD-125 and VRD-200 meat grinders

The VRD-125 and VRD-200 meat grinders (LLC MILA-M, Russia) are designed to grind frozen meat pieces not exceeding 0.2 kg or chilled boneless, trimmed meat, meat by-products, backfat and other raw materials, mass of pieces not exceeding 0.35 kg, as well as meal in raw, cooked, blanched form for the production of cooked, raw smoked and semi-smoked sausages, frankfurters, chopped semi-finished products, culinary products, etc. (Table 2). The construction provides for quick disassembly and assembly of the grinding mechanism. It ensures the even flow of meat through the cutting unit. At the same time, it eliminates fat clogging and heating of meat products. It consists of the body, drive, two grinding mechanisms (auger), set of replaceable plates for different grinding ratio, output nozzle, pressure ring, control unit. The parts and assemblies in contact with the product are made of stainless steel (https://euro-pack.ru/volchok-vrd-125a).

### 3.4 Industrial Meat Grinder B-132-114

The industrial meat chopper with productivity not less than 1000 kg/hour is used for grinding boneless meat for the purpose of obtaining minced meat. Grinder is suitable for grinding of fresh and chilled meat not less than minus 2  $^{\circ}$  C and to obtain minced meat from beef, pork, poultry in the production of sausages and other meat products. It can also be used for grinding other products with similar consistency. Meat or other raw materials are loaded into a

Journal of Experimental Biology and Agricultural Sciences http://www.jebas.org

Technical characteristics and construction features of meat grinders: A mini review

Table 1 Main technical characteristics of the two meat grinder (MIM-300 & MIM 600)

Name of parameter	MIM-300	<b>MIM-6</b> 00
Technical performance (kg/h)	300	600
Rated power consumption (kW)	1.90	2.71
Motorpower (kW)	1.5	2.2
The power supply: rated voltage (V) rated current frequency (Hz)	380 50	
Augerrotation speed (rpm)	250	
Overall dimensions, mm, no more than length width height	680 400 460	765 400 540
Weight, kg, nomore	42	55

Table 2 - Technical specification of the meat-grinder VRD-125 and VRD-200

Name of parameter	VRD-125	VRD-200
Outer diameter of the cutter plate (mm)	125	200
Technical performance (kg/h)	2000	2500
Motorpower (kW)	15	15
Overall dimensions (mm)	1340 x 1070 x 1260	1340 x 1070 x 1260
Weight, kg, nomore	500	550



Figure 2 – The meat grinder: 1- the pusher; 2- the meat grinder; 3- shaft drive; 4- oil level control hole; 5- front trim; 6- drainage plug; 7equipotential clamp; 8- rear trim; 9- motor; 10 - "run" button; 11 - "stop" button; 12 - tap; 13 - safety cup; 14 - clamp; 15 - support; 16 clamp block; 17 - indicator

Journal of Experimental Biology and Agricultural Sciences <a href="http://www.jebas.org">http://www.jebas.org</a>

S364

## S365

receiving hopper with a hopper capacity of at least 100 litres. Under its own weight, the meat is fed into the auger. For the safety of the operating personnel, the upper part of the hopper is protected by a hinged grid with an interlock and an open sensor. In the lower part of the hopper the meat is captured by a auger and fed to the cutting mechanism for further grinding. It has a reversal mode, allowing the auger to rotate in the opposite direction if necessary in order to return the product residue from the cutting block back to the hopper neck. The knife block consists of a receiving plate, two knives with an intermediate plate and an output plate. The grinding degree of the product is from 3 mm. The grinder is completely made of stainless steel, including the frame, trim, folding grate, cutting mechanism and fully meets the requirements of food production. The grinder is installed on independently heightadjustable supports, which allows the grinder to be accurately positioned horizontally to avoid vibrations during operation (http://tsib.agroserver.ru/tovari/1025448.htm).

The meat grinder auger is made of high-strength food-grade stainless steel and ensures a continuous supply of minced meat to the cutting mechanism. The motor-reducer with power of 5.5 kW provides productivity of the grinder at least 1000 kg/hour (Table 3).

## 3.5 Meat grinder K7-FVP-160-2

This meat grinder is designed for medium and fine grinding of the meat raw materials (Figure 3). It consists of four main mechanisms: feeding and cutting mechanism (2), drive and frame on which all assembly units, parts, electric motor (9) and starting electric apparatus are mounted. The grinder also includes a booster plate (1), knife shaft (3), single-coil blade (5), wedge transmission (8) of the knife shaft, platform (10) for sanitary treatment, tray (11) and tubular nozzle (12) (https://food-mechanics.ru/?p=595). Feeding mechanism includes hopper (6) and augers (4). The cutting mechanism consists of a booster plate (1), an outlet cutter plate (2), knives (3), an intermediate plate (4) and a receiving plate (5), and a cylinder with inner ribs and a wheel nut with a tubular attachment. The knives are made of two parts and have curved teeth, in between which there are channels for the product. The blade rotation speed (8.3 s<sup>-1</sup>) is higher than that of the auger (3.3 s<sup>-1</sup>).

This is achieved by the fact that the shaft that drives the blade rotation goes inside the working auger and has its own drive. The auger has hollows at the feeding point for filling and the hopper underneath the auger has cut-off fins. This design ensures a uniform and uninterrupted flow of product into the operating zone.

The number of spiral ribs is more than twice the number of ribs on the side of the feed hopper, which eliminates the return of the product to the hopper. The 8 mm thick output plate is pressed by a rigid support with radial sharpened ribs. The design of this support allows the use of plates up to 3.0 mm thick. The drive consists of an electric motor (9), a spur gearbox and a V-belt gearbox (7).

Journal of Experimental Biology and Agricultural Sciences http://www.jebas.org Table 3 - Technical specification of the meat-grinder B-132-114

Nameofparameter	Value
Technical performance (kg/h)	1000
Outer diameter of the cutter plate (mm)	114
Diameter of holes of cutter plate (mm)	3; 5
Hopper volume, l, not less	100
Augerrotation speed, rpm	280
Three-phase supply voltage, V 3N $\sim$	(380±10%)
Motorpower (kW)	5.5
Overall dimensions (mm)	950x800x1300
Weight, kg, nomore	170



Figure 3- Meat grinder K7-FVP-160-2

The grinder works as follows: trimmed meat in pieces weighing up to 0.5 kg is fed into the hopper, from where it is picked up by the working and auxiliary augers and sent to the area of the cutting mechanism. In this zone the meat is ground to a defined degree, which is ensured by installing knives and cutter plates with appropriate hole diameters. Technical characteristics of the grinders (without loading devices) are given in Table 4.

## Technical characteristics and construction features of meat grinders: A mini review

S366

Name of parameter	K6-FVP-120	K7-FVP-160-2
Technical performance (kg/h)	2500	5000
Outer diameter of the cutter plate (mm)	120	160
Motorpower (kW)	12.5	32.2
Overall dimensions, mm	1600´900´1600	1900´1000´1650
Weight, kg, nomore	800	1200

Table 4 - Technical specification of the meat-grinder

Table 5 - Technical specification of the meat-grinder B-2-114

Nameofparameter	Value
Technical performance (kg/h)	1000
Motorpower (kW)	5.5
Outer diameter of the cutter plate (mm)	114
Augerrotation speed (rpm)	220
Number of augers	1
Meat pieces size (mm)	150 x 35 x 25
Overall dimensions (mm)	
length	700
width	800
height	1180
Weight (kg)	270

## 3.6 The grinder B-2-114

The grinder B-2-114 is designed for grinding boneless trimmed meat, meat cuts, meat and bone by-products and back fat. The product's temperature should be within the limits from 0 °C to +8 °C. Grinder B-2-114 can be used at the enterprises of small capacity for meat processing to produce sausage products (http://meaten.ru/m2c112g113-g2-spinnerv2114.php).

In order to obtain minced meat of different degrees of grinding the grinder B-2-114 is equipped with a set of cutter plates, with hole diameters of 3, 5, 9 and 30 mm, the input plate and two double-sided cross knives (the product is completed with two sets of cutting tools).

Receiving hopper is made of stainless steel and is equipped with a safety grating, preventing the hands of service personnel to access the feed auger during operation. Technical characteristic of the meat-grinder B-2-114 is given in Table 5.

## 3.7 Meat-grinder M-50S

Meat-grinder M-50S (LLC Factory "TorgMash", Russia) is designed for grinding meat and fish in the production of minced meat for various meat and fish dishes in public catering enterprises (canteens, cafes, restaurants), children's institutions and small businesses. The meat grinder (Figure 4) consists of a drive mechanism and a meat grinder attachment (http://www.torgmash.perm.ru/).

The meat grinder's operation: meat thoroughly separated from bones and cartilage, cut into pieces weighing 50-70 g, is pushed from the tray into the neck of the nozzle-grinder. The rotating



Figure 4 Meat-grinder M-50S: 1 - drive mechanism; 2 - meat grinder attachment; 3 - clamping screw; 4 - pusher; 5 - loading tray

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### Table 6 Technical specification of the meat-grinder M-50 S

Name of parameter	Value
Technical performance (with hole diameter of cutter plate ø5 mm) (kg/h)	50-80
The power supply: rated voltage (V) ratedcurrentfrequency (Hz)	220 50
Ratedmotorpower (kW)	0.55
Augerrotation speed (rpm)	192
Outer diameter of the cutter plate (mm)	60
Diameter of holes of cutter plate (mm)	5; 9
Overall dimensions, mm, no more than length width height height with pusher	500 265 360 405
Weight, kg, nomore	20

#### Conclusion

The review showed a variety of meat grinders, both in design and technical characteristics. Meat grinders differ in size, cost, functionality and other attributes. The power of the meat grinder varies from 0.55 kW to 32.5 kW, depending on the household or industrial use.

## **Conflict of Interest**

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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## **Online Support**

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