RESEARCH CONCERNING THE ACHIEVEMENT OF SOME APPLES SORTING EQUIPMENTS

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ABSTRACT

According to the present interest of the government to encourage the fruit consumption by the scholars, especially the apple consumption, two functional model of technical equipment for sorting apples have been designed, manufactured and tested in INMA Bucharest. These equipments can be used for sorting also others fruits with spherical shape such as oranges, peaches, grapefruits etc. The mechanized sorting process conducts to valorisation of the farmer's production and to increase their turnover, thus is necessary to analyse and improve this process, by optimizing the working parameters.

INTRODUCTION

Low fruit and vegetable consumption is one of the top 10 global risk factors for mortality according to the World Health Organization (WHO) [11,4]. Increased fruit and vegetable consumption can help protect overall health status and reduce both disease risk and burden [12, 4]. Fruit and vegetable intake is a key factor in preventing major illnesses such as cardiovascular diseases and certain cancers, yet the majority of Americans, including children, consume far less than the recommended number of servings per day [1,3,5].

In the abroad there is a great interest for production and consumption of fruits and vegetables due to their positive effect on the health of the body. As a result, this activity was very high developed, but it went too far on genetically modified organisms, something which is currently under discussion, health researchers sounding the alarm on the effect of long-term consumption of these products. It is noted that in Romanian hypermarkets there are traded not native fruits, they are imported, their appearance clearly proving that intervened at the genetic level or have been treated with chemicals.

Large countries producing fruits (USA, France, Italy, Spain, Turkey, Poland, Germany), study specific modalities to keeping the short, medium and long term quality post-harvest horticultural products so that they can be valued and beyond production period. The growing interest in this area arose from the need to increase the marketing period for fresh fruits, to avoid periods of market saturation and get a better value / price and ensuring export fruits involving transport periods long.

There are known companies in the abroad that produce complex installations sorting, such as CALIBREX (France) [8], COMPAC (Auckland, New Zealand) [9], FRUMAC (Poland) [10], and others, but their addressability is the high production farms, where significant quantities of fruit are harvested, where there should be storage warehouses with controlled environments, by specific insulation storage cells, equipped with monitoring and control of environmental preservation in controlled atmosphere (temperature, humidity, atmospheric concentrations of O_2, ethylene content etc.). These installations performed sorting by size, weight, health, firmness, fruit color, and therefore the cost price is quite high. For this reason, these installations do not address small producers, amortization of acquisition costs being rapidly only if large productions, so in case of large farms.

In terms of farm size, externally it goes on large size plantations, which requires mechanization suitable large productions, both in terms of maintenance of plantations, fruit cultivation, especially harvesting, sorting, grading and storage, for disposal or processing of fruits market.

Sorting apples falls within current preoccupations of the government, to promote apple consumption among children, according to European Union program to encourage the consumption of fruit in schools, 22 July 2009.

The European Agriculture and Rural Development Commission, concerning the distribution of fruit in schools, in 2011-2012, showed in 2013 that the EU average fruit or apple was 136 g/student, Romania ranked 13 of 23 countries analyzed, with an average of 115 g/apple versus Bulgaria - 328 g, Poland, Belgium, Italy - 210 g, Slovakia - 200 g etc. In terms of average price, it was 0.31 €/apple/136g at EU, Romania spending 0.07 € / apple among the lowest rates per unit of product.

For this reason, has been designed, developed and tested at NATIONAL INSTITUTE OF RESEARCH - DEVELOPMENT FOR MACHINES AND INSTALLATIONS DESIGNED TO AGRICULTURE AND FOOD INDUSTRY - INMA Bucharest, a functional model of machinery for sorting apples and other fruits by round shape, so as to can shorten the time required for this process, in order to arrive the fruit in schools, as quickly as possible, to the students, the main consumers, and also to be able to capitalize faster production of farmers in fruit farms. These researches have been realized in the National Research Program – ADER, within the project ADER 311, held by Agricultural and Rural Development Ministry.

Additional, it was also developed research concerning the achievement of machinery designed to sort the fruits by their mass.

MATERIAL AND METHOD

To design these equipments have been studied the solutions applied in the abroad and was used specialised 3D software, SOLIDWORKS.

Sorting equipment by dimension (diameter) (fig.1) made at INMA Bucharest is a special calibrated roller, designer for semi-subsistence farms.

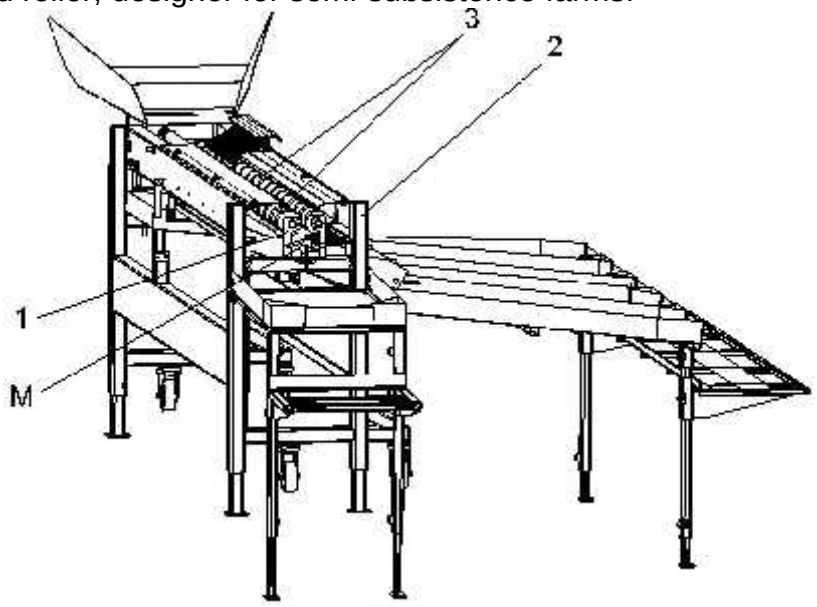

Fig.1 - Technical equipment for sorting apples by size – side view

Equipment for sorting & calibrating fruit, with simultaneous adjustment of the position of rollers consists of a welded frame (fig.1, pos.1), on which is mounted supports (fig.1, pos.2) provided with rolling bearings, spherical, which supports profiled rollers sorting

(fig.1, pos.3) fixed at one end and adjustable to the other, by a mechanism (fig.1, pos.M) for simultaneous displacement transverse to the rollers.

Technical and functional characteristics:

- Sorting dimensional groups:
  - < 60 mm;
  - 60…65 mm
  - 65…70 mm;
  - 70…75 mm;
  - 75…80 mm;
  - 80…85 mm;
  - > 85 mm.
- Transmission:
  - Moto gear : NMRV 30
  - Power of electric motor: 0,18 kW;
  - Input rotation speed: 1400 rot/min;
  - Gear ratio: 25:1
  - Output rotation speed: 56 rot/min
- Overall dimensions:
  - Length: about 3500 mm;
  - Width about 2050 mm
  - High about 1600 mm
- Own weight: about 300 kg

Central equipment (fig.2), constitutes the main part of the equipment, consisting of a frame (fig.2, pos.1), chute control (fig.2, pos.6), special roller (fig.2, pos.11), input, intermediate and final bearings bushings (fig.2, pos.2,3,4), transmission (fig.2, pos.5), brushes amortization (fig.2, pos.8,9,10).

Fig.2 - Central equipment

1. Frame; 2,3,4 Input, intermediate and final bearings bushings; 5. Transmission; 6. Trough; 10. Brush out; 11 Small roller; 13. Holder support; 14. Left roller; 15. Right roller; 16. Swivelling wheels

To avoid mechanical damage, the surface rollers have been covered with soft and elastic as: plastic sponge, spongy rubber etc. The best calibration equipment is that in which the percentage of damaged products does not exceed 8% [2,6,7].

It is known from US patent, nr.4.426.006/1984 a sorting machine that uses an electronic weighing system which uses a chain conveyor fitted with cups.

It is known also from USA patent, nr.4.586.613 a sorting machine that uses a computerized sorting system for fruit and vegetable, all fitted with bucket on a chain.

These machinery have the disadvantages that they have a high constructive complexity, used in the composition of industrial facilities for sorting, not being able to be used individual, require the existence of electrical power phase, require maintenance by specialized personnel, so they are not accessible to small and medium-sized farms.

The equipment developed at INMA Bucharest, for sorting the round fruits by their mass, was designed for reducing the effort of the workers in the semi-subsistence farms. The team work analysed many solutions and finally has resulted the equipment represented in the fig.3. This equipment has a simple construction with cups attached to a belt drive, electric motor driven by a frequency converter and can thus change the speed of advance of the cups.

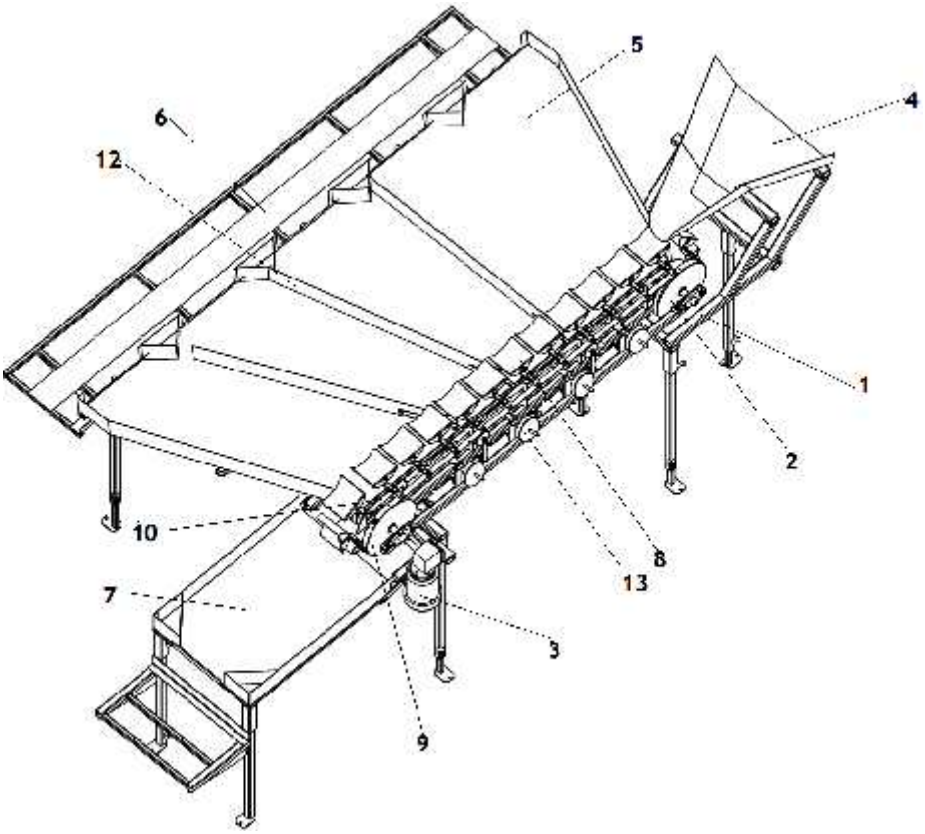

Fig.3 - Technical equipment for sorting apples by mass – side view

Equipment for sorting apples by mass, according to the invention, consists of a welded frame (fig.3, pos.1) on which is mounted a transmission belt (fig.3, pos.2) driven by a gear motor electrical frequency converter (fig.3, pos.3), a supplying box (fig.3, pos.4), a sorting table (fig.3, pos.5) provided with separators (fig.3, pos.12), a support table (fig.3, pos.6) on which are arranged bins for collecting apples separated by fractions, in the end of the table (fig.3, pos.7) for collecting apples with small masses, a fixed guide (fig.3, pos.10) fitted with successive sections horizontal and recesses, a set of cups (fig.3, pos.8) as a cylindrical sector, coated with rubber cloth cover (plastic or semi-hard), which has at the bottom a roll (fig.3, pos.11) which allows the movement of the cup (fig.3, pos.10) along

the fixed guide (fig.3, pos.10), set with successive sections and horizontal recessed and a lever (fig.3, pos.9), provided by the counterweight (fig.3, pos.13) on which the roller that issuing cup fruit, placed in the right sector with the guide recesses (fig.3, pos.10).

Apples loaded in the tank (fig.3, pos.4) falls in the cup (fig.3, pos.8) which moves together with the belt of the transmission (fig.3, pos.2), the cups being directed along a profiled guide (fig.3, pos.10), and when the combined cup-apple reaches the one of the lever (fig.3, pos.9), the balance of moments of the cup + apple and lever assembly + counterweight causes rotation of the lever (fig.3, pos.9) in joint support of it, causing rotation of the cup and fall apple on the main sorting table (fig.3, pos.5), table that has more areas of separation according to group apples sorted in checkweighter area.

Depending on the tarring of the assembly lever (fig.3, pos.9) + counterweight (fig.3, pos.13), can get more groups of sorting, placing separators (fig.3, pos.12) on sorting table making the sorting order of weight fractions. Apples are sorted into the four main groups sorting.

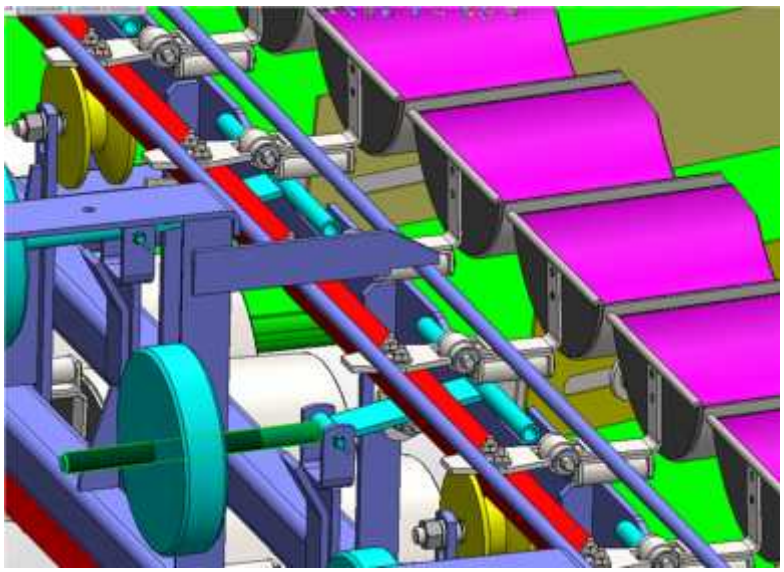

Fig.4 - Sorting equipment by apple mass - detail

Apples are loaded in a tray driven by a vibrating electric motor, the tray by triangular section to avoid access to the cup more than one apple.

RESULTS AND DISCUSSIONS

The equipment designed to sort apples by dimension has been calibrated and have been performed three repetitions for each apple variety. Experiments were conducted with three apples varieties: Idared, Golden and Ionathan.

Apples were measured with calipers on the two dimensional size, height and diameter and have been separated by the groups that can be performed by the equipment and the results were centralized.

Fig.5 - Testing sorting equipment by dimension–working process aspect

The results of functional tests, shows that by corresponding adjustment can be sort fractions, on the desired dimensions, namely the 5 main fractions (60 ... .65 mm, 65 ... 70 mm, 70 ... 75 mm, 75 ... 80 mm, 80... 85 mm) and two secondary fraction (D ≤ 60 mm and D≥85 mm).

There are some problems because the dimensions (diameter and high) are different, the ration *K* between these two dimensions is not 1, so it is necessary to calibrate the angle of the sorting rollers for each apple variety.

Relation, *K*, between the size of the apple in two perpendicular directions is:

$$K = \frac{H}{D} \Rightarrow \quad (1)$$

where:

H is the high of the apple;

D – diameter of the apple.

This ratio *K* has the values:

Ionathan	K = 0,86
Golden	K = 0,88
Idared	K = 0,90

Apple sorting equipment by weight has been tested concerning their functionality, and has been upgraded to be able to separate the apples, with a rubber conveyer, actioned by the same electric motor which drives the belt transmission.

In fig.6 we can see an image of the working process.

Fig.6 - Testing sorting equipment by weight–working process aspect

Sorting by weighing is based on the equilibrium of moments.

There were performed tests for the functional model on three main varieties of apples: Golden, Ionathan, Idared, taking into account their mass.

Taking into account the physical proprieties of these varieties, there were identified four intervals in which to make sorting by weight:

- ≤ 110 g;
- 100 ... 190 g;
- 190 ... 230 g;
- ≥ 230 g.

CONCLUSIONS

After tests, the following conclusions were established:

- The equipment for sorting apples by size, one line sorting, has an average capacity of 450 kg/h, depending on the apple variety;
- The equipment for sorting apples by mass must continue to be developed, and to be tested in real conditions;
- Using this equipment for sorting apples in semi-subsistence orchards farms will solve one of the needs of Romanian horticulture valuing its production, domestic sales of fruit production through the creation of regional markets.

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