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STUDY REGARDING THE ENERGY CONSUMPTION OF THE CONDITIONING OPERATION OF CUTTING OF FRESH AND DRIED MEDICINAL PLANTS

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Abstract: *The paper presents the results of experimental research in the laboratory and in operation for studying the cutting fresh and dried medicinal plants. Cut resistance was tested for the studied medicinal plants (St. John's wort, mint and yarrow), using knives with different cutting angles and three speeds. Active energy consumptions were calculated for cutting medicinal plants both in the laboratory and operation. Processing and plotting the results, as well as the behavior of the technical equipment during the experimental research led to conclusions regarding the energy consumption of the conditioning operation of cutting fresh and dried medicinal plants.*

Key words: *conditioning by cutting, dried herbs, fresh herbs, energy consumption.*

1. Introduction

The experimental research subjects were three medicinal plants (St. John's wort, mint and yarrow, fresh and dried) from the spontaneous flora.

St. John's wort *(Hypericum perforatum L.)* of family *Hypericaceae*, genus *Hypericum*, species *Hypericum perforatum L.* (Figure 1) is a perennial herbaceous plant, with a straight cylindrical stem branched at the top and slightly woody in the lower part. The opposite arranged leaves contain many secreting bags that give the impression of the presence of translucent dots. The flowers are of golden yellow color and are grouped at the top of the stem and branches [2].

Mint (*Mentha piperita L.*) of family *Lamiaceae*, genus *Mentha*, species *Mentha x piperita L.* (Figure 2) is one of the oldest known medicinal plants. Mint is an annual herb with a well branched aerial part. The plant is characterized by the fact that it does not fructify and it reproduces exclusively by stolons. The leaves are arranged oppositely, they are sharp at the top and have a dark green color on the top and a lighter color at the bottom [2].

Yarrow (*Achillea millefolium L.)* of family *Compositae*, genus *Achillea*, species *Achillea millefolium L.* (Figure 3) is a vivid herbaceous plant, growing in cultivated and uncultivated places, up to 80 cm high. The leaves are alternate, with slightly fragrant odor and bitter astringent taste, and the blossoms are white, pink or gray [3].

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Fig. 1. *St. John's wort*

Fig. 2. *Mint*

Fig. 3. *Yarrow*

2. Experimental research methodology

In order to achieve the overall objective of the experimental research, as well as the secondary objectives an experimental research methodology was designed and followed. In order to fulfill the general methodology the following activities were conducted: actions prior to experimental research, experimental research in the laboratory and experimental research in operation.

2.1. Equipment and appliances used in experimental research

In order to conduct the experimental research multiple pieces of equipment, appliances and tools were used, such as: medicinal plant cutting equipment Herbcut TS 1340; material testing equipment Zwick/Roell 5.0 N; apparatus for measuring electrical energy consumption CA 8334B; lab oven Froilabo AC60; analytical scale KERN EG 420-3NM; thermal scale OHAUS MB45; calcination furnace Nabertherm etc.

2.2. Conducting experimental research in the laboratory

The laboratory experimental research was carried out in the laboratories of the Faculty of Food and Tourism of the Transilvania University of Brasov, from June to August 2013 and were aimed at perfecting technologies and equipment for conditioning medicinal plants.

Determinations of active ingredients (essential oils) were carried out, as well as humidity and ash content, before and after conditioning the medicinal plants.

2.3. Determining moisture content of medicinal plant samples

To determine the moisture two methods have been used: oven drying and using a thermal scale. The determination of the percentage of moisture was performed using the relation:

$$U = \frac{b-c}{b-a} \cdot 100 \quad [\%], \tag{1}$$

where:

U represents the moisture of the sample, in %;

a – mass of the glass container on which the sample is placed, in g,

b – mass of the container with the sample, in g;

c – mass of the weighing container with dry product, in g [1].

2.4. Determining total mineral substances (ash)

Total mineral substances are the residue obtained after the calcination of an inorganic or organic substance and is expressed in mass percentages.

Determination of ash was performed by the formula:

$$Ash = \frac{c-b}{a-b} \cdot 100 \ \ [\%], \qquad (2)$$

where:

- a is the mass of the crucible with the initial product, in g;
- b – mass of the empty crucible, in g;
- c – mass of the crucible with the product, after calcination, in g.

2.5. Determining essential oil content by water vapor

Essential oils are generally liquids insoluble in water, but soluble in organic solvents. The presence of essential oils in a vegetal product is easily observed from the presence of the odor which, in part, will volatilize in the external environment.

The results of the determinations for the three medicinal plant species in fresh and dried state are presented in a tabulated form as a qualitative analysis report (Table 1).

Bulletin of qualitative analysis of medicinal plant samples Table 1

Species	Moisture, [%]	Ash, [%]	Essential oil, [%]
St. John's wort – fresh herb	77.73%	1.05%	0.07%
Mint - fresh herb	75.26%	2.04%	0.36%
Yarrow – fresh herb	72.77%	2.62%	0.21%
St. John's wort – dried herb	11.75%	10.33%	0.26%
Mint – dried herb	11.33%	9.50%	0.98%
Yarrow – dried herb	9.50%	8.33%	0.38%

2.6. Determining the cutting resistance of the studied medicinal plants

Three sets of determinations were made for 1, 3 and 9 plant parts. Unilateral knives with straight blades were used with different sharpening angles of 15, 30 and 45° and three working speeds, namely 50, 150 and 300 *mm/min*. The database was stored and then the results were processed to determine the energy consumption for cutting, using Microsoft Excel (Figure 4).

Fig. 4. *Images taken during the experimental lab research*

After processing the data recorded by the material testing equipment Zwick/ Roell 5.0N, diagrams were drawn which outline the variation of resistance to cutting for fresh and dry medicinal plants.

The diagrams in Figures 5...7 represent the variation of resistances obtained when cutting the three species of medicinal plants in fresh and dry state using knives with straight blades and sharpening angles of 15, 30 and 45°.

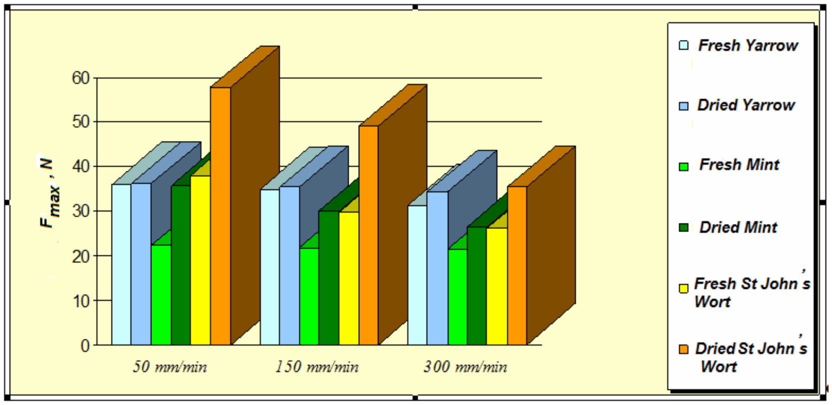

Fig. 5. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angle of 15°*

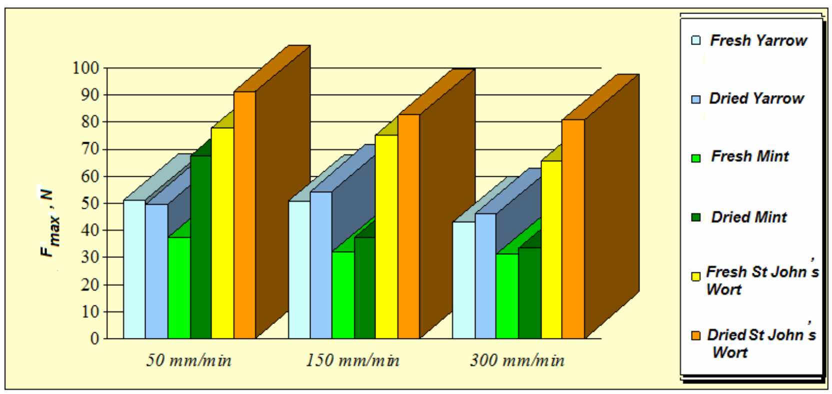

Fig. 6. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angle of 30°*

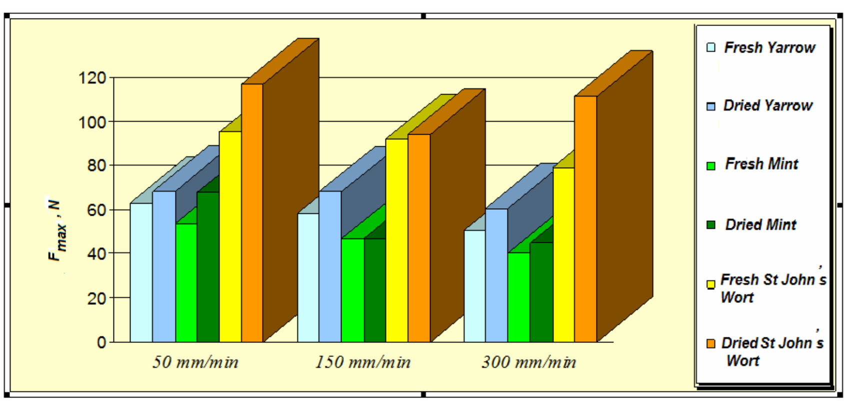

Fig. 7. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angle of 45°*

The presented charts show that the speed influences the cutting process of medicinal plants, meaning that cutting resistance force decreases with an increasing working speed.

Thus, at a speed of 50 *mm/min* the cutting resistance force of fresh mint was 57.59 *N*, while at a speed of 300 *mm/min* it decreased to 44.86 *N*.

The diagrams in Figures 8...10 represent the variation of resistances obtained when cutting the three species of medicinal plants in fresh and dry state using knives with straight blades and sharpening angles of 15, 30 and 45°, at a working speed of 50, 150 and 300 *mm/min*.

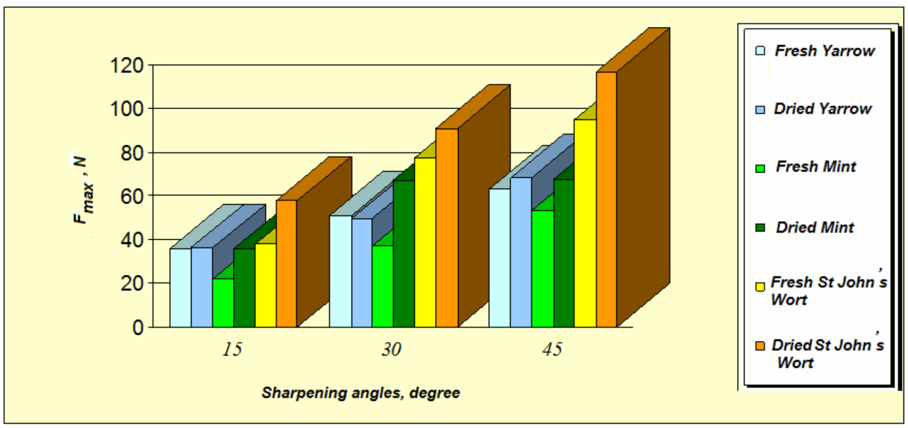

Fig. 8. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angles of 15, 30 and 45°, at a speed of 50 mm/min*

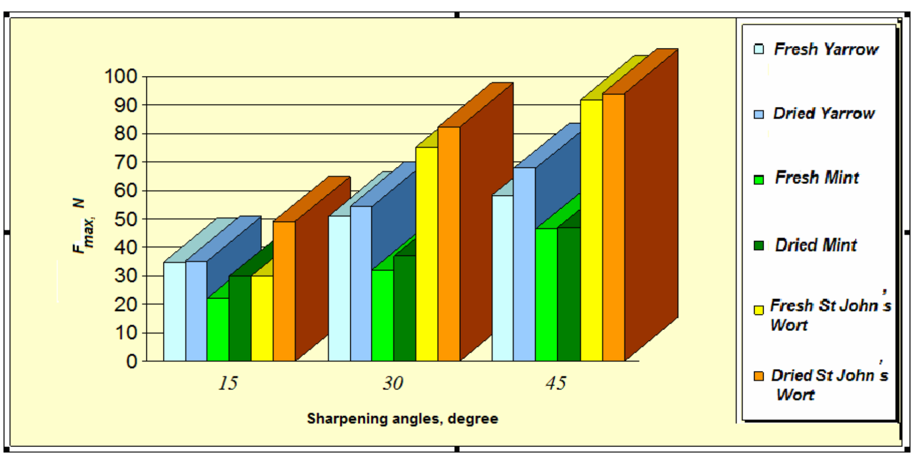

Fig. 9. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angles of 15, 30 and 45°, at a speed of 150 mm/min*

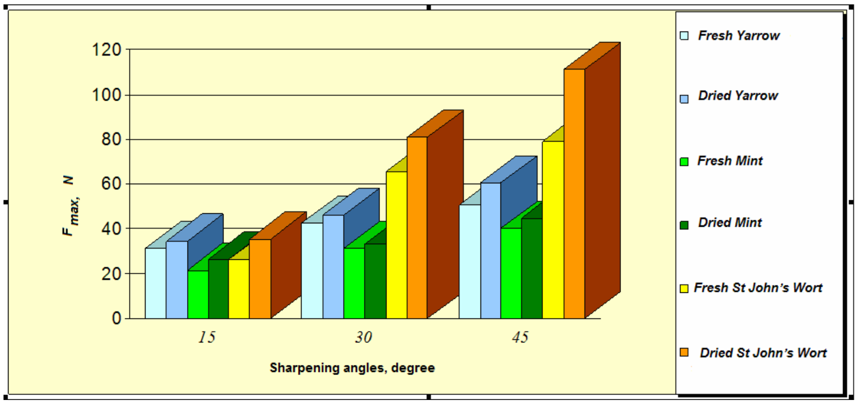

Fig. 10. *Variation of the cutting resistance force values obtained when cutting the three species of herbs with a straight edge knife and sharpening angles of 15, 30 and 45°, at a speed of 300 mm/min*

It can be observed that the knife's sharpening angle influences the cutting process, meaning that the values of cutting resistance forces increase proportionally with increasing the knife sharpening angle. Thus, when cutting fresh mint with a knife having a sharpening angle of 15° a cutting resistance force of 21.55 *N* was recorded, while when cutting with a knife having a sharpening angle of 45°, the recorded cutting resistance force was 40.24 *N*.

2.7. Conducting experimental research in operation

The experimental research in operation was carried out in the research laboratory „Technologies in Food Industry" at I.N.M.A. Bucharest between June-August 2013. The fresh and dried medicinal plants were cut in two sizes of 5 and 12 mm.

From Figure 11 it can be seen that the *active energy* W_p consumed for cutting the plants, in a time of 17 seconds is the area of the surface between the power variation graph and the x-axis and it represents the sum of the areas of the „n" rectangles formed. This energy can be calculated using the formula:

$$W_p = \sum_{k=1}^{n} P_k \cdot t \qquad (3)$$

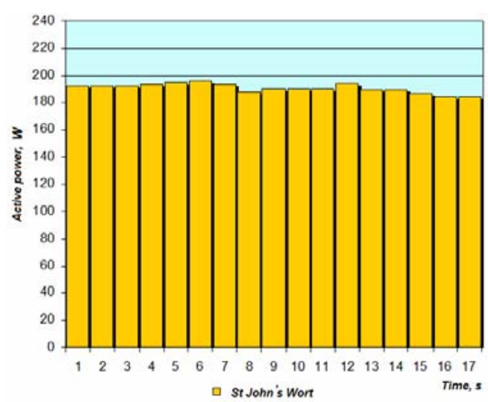

Fig. 11. *Variation of active power in the process of cutting fresh St. John's wort*

Exemplifying, during the cutting process of 0.25 *kg* fresh *St. John's wort*, respectively 66 plant parts, the active energy consumed was W_p = 3244 *W·s*. The consumed energy without load (Figure 12) was 3048 *W·s*. The actual active energy that was consumed in the cutting process was 196 *W·s*.

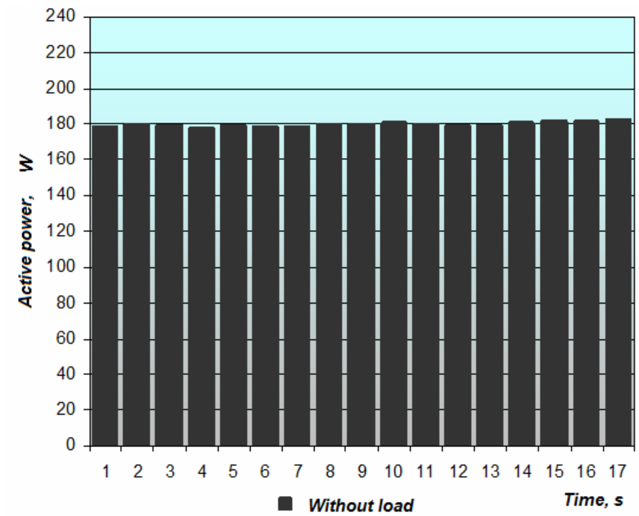

Fig. 12. *Active energy without load*

The cutting energy using the Zwick/ Roell 5.0N (163 *J*) is lower than the measured one (196 *J*) because, during the cutting process there are some other energy consumptions, such as: the energy consumed for transporting the products and the one due to friction between plants and the conveyer belt in the process of compressing them before cutting (Figure 13).

It was concluded that the active energy actually used in the cutting process is very low, representing about 1.4...6.4% of the total consumed energy.

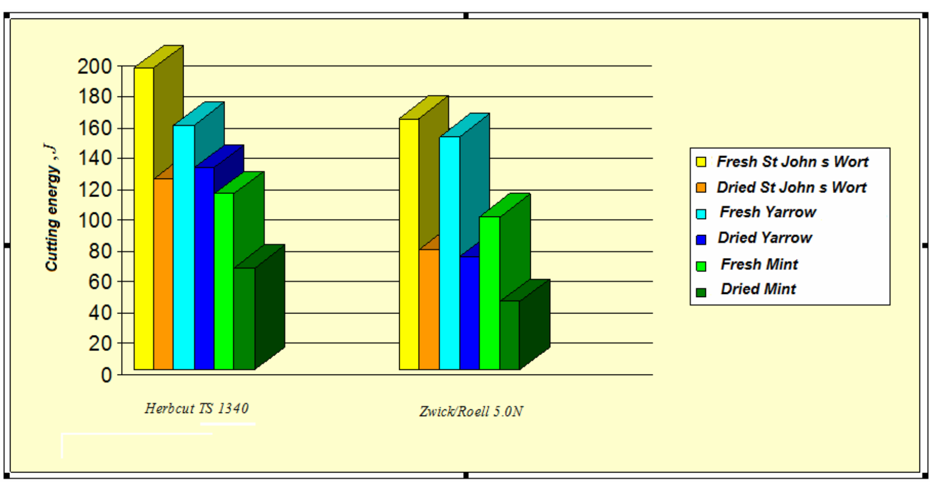

Fig. 13. *Cutting energies of the three plant species measured in experimental research in operation and laboratory*

3. Conclusions

- From the experimental research carried out in operation it can be seen that the active powers measured in the cutting process were always greater for fresh plants, compared to the dry ones. Thus, for example, in the case of cutting fresh mint the active power recorded a maximum of 188 W, while with the dry mint it reached a maximum of 183 W.
- From the calculations it can be seen that the active energy actually consumed in the process of cutting is very small, accounting for about 1.4...6.4% of the total consumed energy. As a conclusion, the technical equipment used in this case should be designed such as the energy consumption without load to be minimal.

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References

1. Mărculescu A., 2004. Technology of Processing and Using Medicinal Plants (in Romanian). Lucian Blaga University of Sibiu Publishing, Sibiu.
2. Păun E., 1986. Treaty of cultivated medicinal and aromatic plants (in Romanian). R.S.R. Academy Publishing House, Bucharest.
3. Pârvu C., 2000. Plant Universe (in Romanian) Encyclopedic Publishing House, Bucharest.