STUDIES AND RESEARCH ON THE POSSIBILITIES OF CUTTING ANALYSIS OF FOOD MATERIALS WITH SOFT TEXTURE

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Abstract: This research presents (treats) the studies and experimental analyses in the field of mechanical shredding of the food materials which have a soft texture. The results can provide a clarification in analyses terms of the cutting aspect. Other important goals of this research are: the analysis of quantitative and qualitative material losses and the determination of the necessary forces to shred at different working speeds.

Keywords: cutting, food material, soft texture.

1. INTRODUCTION

The cutting operation represents the reduction of geometric dimensions of particle due to the action of external mechanical forces (the action of the cutting device) [1, 2].

The food material is that naturally product from vegetable or animal origin, which represents a raw material for processing in an industrial process or can be consumed as such [3-7].

In the category of food materials with soft texture are:

- materials from vegetal origin:
  - natural: fruits and vegetables with soft texture (apricots, peaches, cherries, strawberries, grapes, tomatoes etc.);
  - synthetic: turkish delight, marmalades, jellies etc.;
- materials from animal origin:
  - obtained from milk products (some soft cheeses, butter etc.);
  - meat products with a soft texture.

2. THE PROPERTIES OF FOOD MATERIALS WITH SOFT TEXTURE THAT INFLUENCE THE CUTTING OPERATION

The properties of food materials with soft texture that influence the cutting operation are [2, 8]:

- physical properties: moisture;
- mechanical properties: the geometric shape and particle size, particle's resistance to cutting;
- elastic properties: elasticity;
- technological properties: particle's density, particle's hardness;
- textural properties: texture (rheological characteristics of food product, which confer resistance to the action of external forces - compression, shearing, cutting etc.).

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3. RESEARCH GOAL

The studies and experimental research in the field of shred by cutting of food material with soft texture are particularly important, their results can provide more clarification in terms of analysis of the cutting aspect, the analysis of quantitative and qualitative material losses, the determination of the necessary forces to shred at different working speeds.

4. EXPERIMENTAL RESEARCH

The studies of the cutting of food materials with soft texture in the laboratory conditions were applied using texture analyzer type TA.HDPlus (Figure 1), analysis of data obtained during each determination being rendered by specialized software Texture Exponent. The principal features of this type of texture analyzer are the following [9]:

- The weight of the device: 38 kg;
- Cells of force are: 50, 300, 500, 1000, 2500, 5000 and 7500 N;
- Operating distance: from 0.1 to 524 mm;
- Resolution: 0.001 mm;
- Operating speed: 20 ÷ 0.01 mm/sec.

Fig. 1. Texture analyzer type TA.HDPlus.

Using the texture analyzer type TA.HDPlus was obtained a full three-dimensional analysis of the samples processed (various materials with soft texture) depending on the force, distance and time.
The texture analyzer TA.HDPlus offers a wide range of probes and measuring devices (needles, knives of various shapes) in order to determine the characteristics of texture. Figure 2 presents the parameters of cutting.

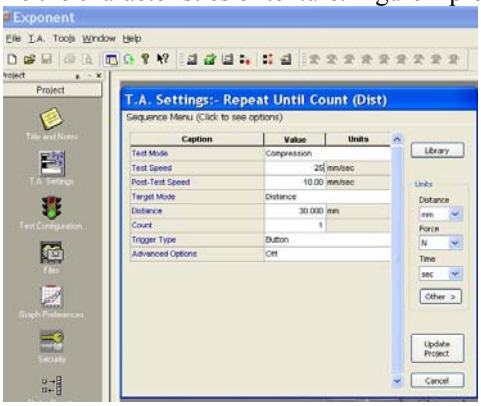

Fig. 2. The cutting parameters.

To achieve the experiences was used the probe HDP / BSK (blade set with knife), which are a classic form of knife blade and is suitable for cutting of food products with soft texture.

For analyzing the mode of propagation of the crack in materials with soft texture analyzed, were used different values of work speed: 40 mm/s, 10 mm/s and 5 mm/s.

By visual analysis of the aspects of products with soft texture shredding by cutting, were followed a series of indices such as adherence to the working body, the cutting aspect, the loss of juice, the keeping of the shape (Table 1).

Table 1. The working indices obtained from shredding of food materials with soft texture.

Nr. crt.	**Food material**	**Adherence at the working body**	**The cutting aspect**	**The loss of juice**	**The keeping of the shape**
1.	Cheese	Small	Regular with materials losses	Reduced	Yes
2.	Tomato	Small	Irregular	Large	No
3.	Peeled oranges	Small	Irregular	Large	No
4.	Strawberries	Small	Regular	Reduced	Yes
5.	Peeled banana	Big	Regular	Nonexistent	Yes
6.	Turkish delight	Big	Regular	Nonexistent	Yes

In the Figure 3 is shown the cutting force variation in time at shredding cheese for different values of cutting speed (40 mm/s, 10 mm/s and 5 mm/s). As can be seen from analysis of obtained data (Figure 3) the cutting forces vary directly with variation of the cutting speed.

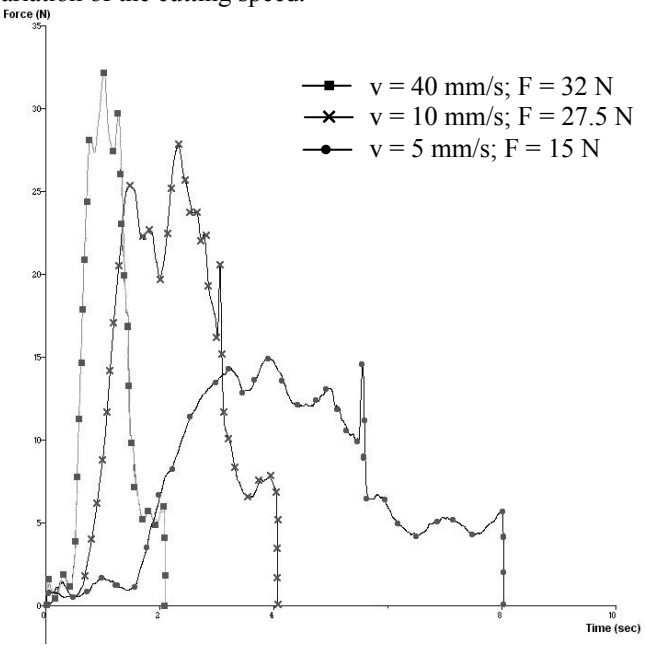

Fig. 3. The variation of the cutting force in time, at shredding cheese for different cutting speeds: 40 mm/s, 10 mm/s, 5 mm/s.

To study the cutting of tomatoes at the fully ripe, the same cutting speeds were used, as in the previous case, the cutting forces recorded higher values at cutting speed 40 mm/s and at speeds of 5 mm/s. Between these values the forces are significantly smaller.

The difference between the values of the cutting forces recorded at shredding of tomatoes compared with the values of the cutting forces recorded at shredding of cheese is represented by the fact, at shredding of tomatoes there are necessary higher cutting forces, due primarily the shell of tomatoes (skin) as shown in Figure 4.

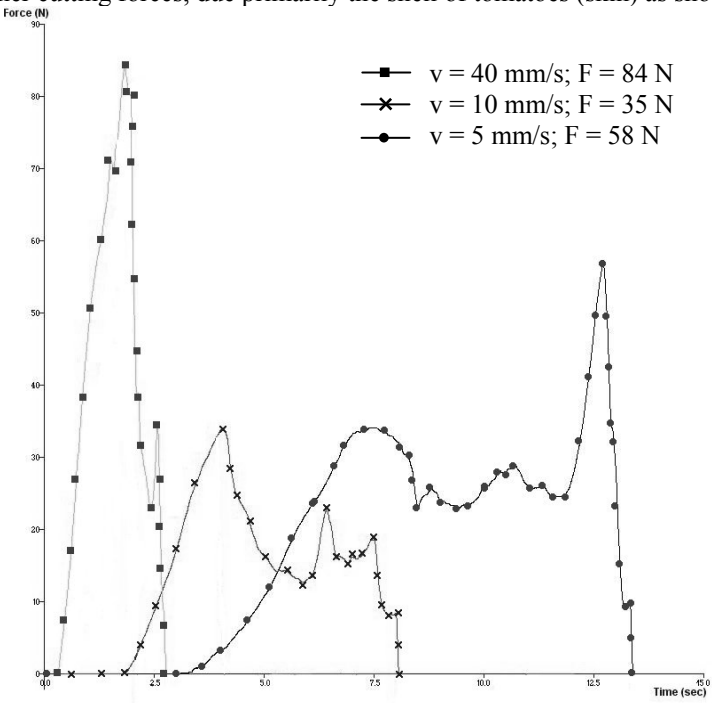

Fig. 4. The variation of the cutting force in time, at shredding tomatoes for different cutting speeds: 40 mm/s, 10 mm/ s, 5 mm/s.

In the case of oranges was found that the cutting forces have the highest values compared with cutting forces obtained at shredding cheese and tomatoes due to their more fibrous structure (Figure 5).

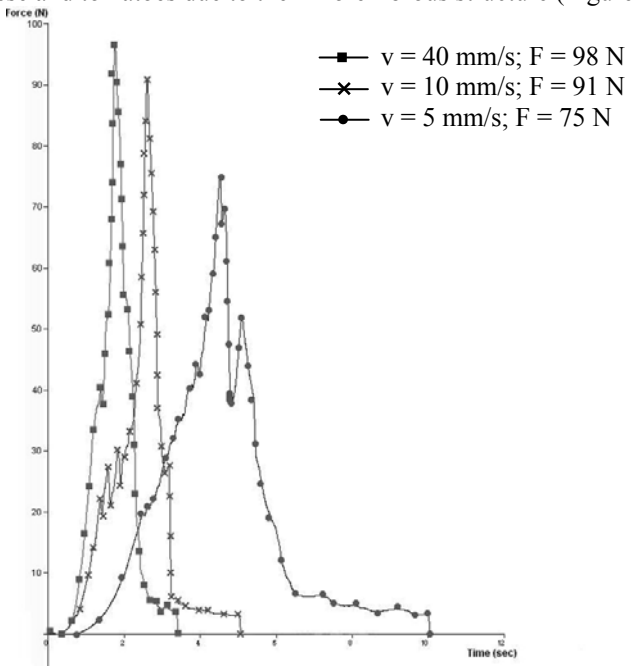

Fig. 5. The variation of the cutting force in time, at shredding peeled oranges for different cutting speeds: 40 mm/s, 10 mm/s, 5 mm/s.

Studies have been extended to other food materials with soft texture: strawberries, peeled bananas and Turkish delight.

In the case of strawberries analysis was found that lower values of cutting force were obtained for a cutting speed of 10 mm/s (Figure 6) , at small values of speed cutting, the force present a significant increase that is explained by the fact that they have a slightly elastic structure.

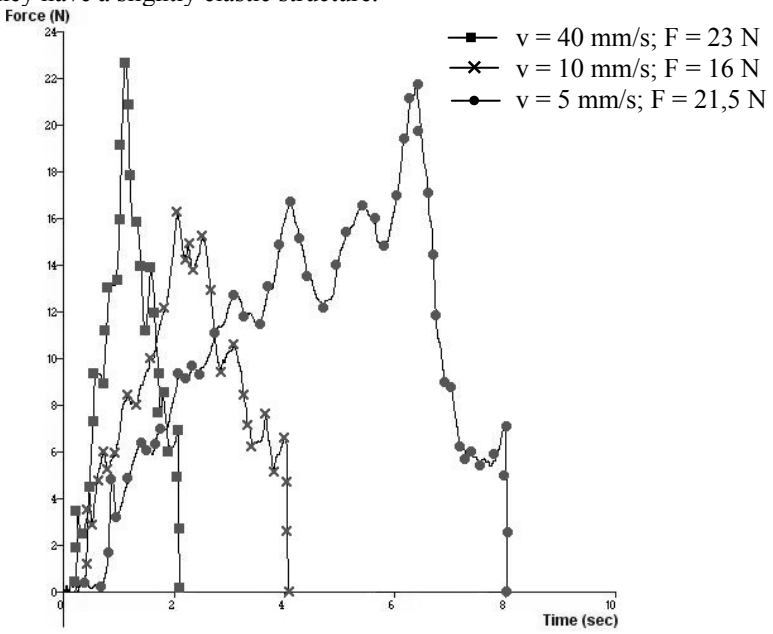

Fig. 6. The variation of the cutting force in time, at shredding peeled strawberries for different cutting speeds: 40 mm/s, 10 mm/s, 5 mm/s.

As for the other types of materials and in the case of bananas were used the same cutting speeds and was found that due to their structure, the cutting forces varies in direct proportion to the cutting speed (Figure 7).

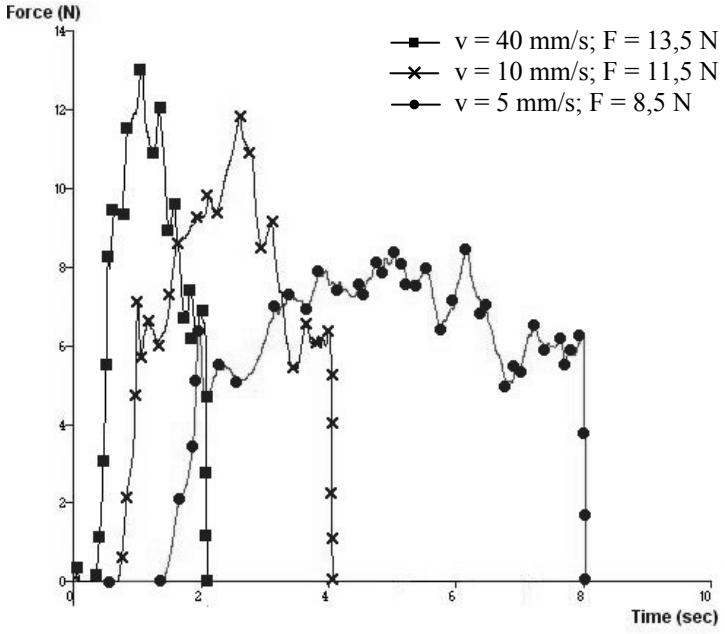

Fig. 7. The variation of the cutting force in time, at shredding peeled banana for different cutting speeds: 40 mm/s, 10 mm/s, 5 mm/s.

In the case of Turkish delight shredding the lowest values of cutting forces were obtained for small cutting speeds (Figure 8) this is due to the relatively homogeneous composition of the material.

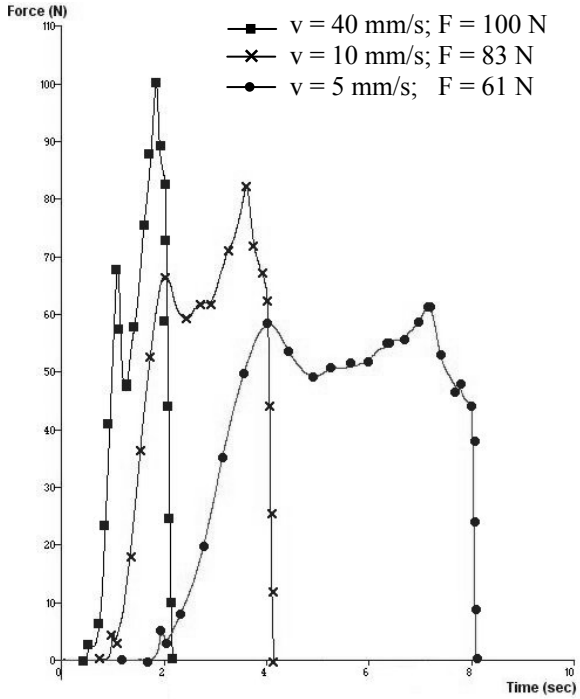

Fig. 8. The variation of the cutting force in time, at shredding Turkish delight for different cutting speeds: 40 mm/s, 10 mm/s, 5 mm/s.

5. CONCLUSIONS

This study aimed to achieve an analysis in laboratory conditions having the subject the behavior of the material under the action of shredding, establish the forces necessary to cutting at different working speeds, the cutting aspect, the establishment of juice and material losses resulting from the cutting process.

From the study of cutting food materials with soft texture is apparent that at high cutting speed, the cutting forces are large and the time is small. With reducing of the cutting speed under the value of 10 mm/s due to specific properties of each material, the cutting times increase with lower cutting forces (in the case of materials such as cheese, peeled oranges, peeled bananas and Turkish delight), except strawberries and tomatoes where there is lower cutting forces at a speed of about 10 mm/s and biggest forces in the extremities (40 mm/s and 5 mm/s).

Also, the cutting device used in the present experiments revealed a number of deficiencies related to product quality resulting from shredding operation, visually determined (Table 1) as follows:

- big losses of juice especially in the case of tomatoes and oranges and lower losses of juice in the case of strawberries and losses of materials in the case of cheese;
- big friction forces in the case of Turkish delight and even banana, the cutting material adhering to the cutting device;
- the irregular aspect of the cutting;
- loss of initial shape of cutting materials especially for tomatoes and oranges.

In the future research to improve the quality of cutting food materials with soft texture is necessary to establish a correlation between the working parameters, textural characteristics of the cutting products, the cutting device, in

order to obtain more regular cutting surface, reducing the losses of materials and juice resulting from cutting process.

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