

LABORATORY TESTS OF THE BELL PEPPERS PROCESSING DEVICE

Summary

Device for hollowing and cutting bell peppers adapted to work in a technological line is objective of the laboratory tests. The device accomplishes three processing stages during one work cycle: hollows a core, removes residual seeds and cuts bell pepper into equal parts. In the article the obtained results are discussed. The results show that the cutting process is proceeding correctly; no adverse changes in bell peppers pulp structure were diagnosed.

Key words: hollowing, cutting, device, bell pepper, vegetable processing

BADANIA LABORATORYJNE AUTOMATU WYDRAŻAJĄCEGO-TNĄCEGO DO PAPRYK

Streszczenie

Przedmiotem badań jest automat wydrążająco-tnący do papryki, który przystosowany jest do pracy w linii technologicznej. Automat realizuje trzy procesy obróbcze w czasie cyklu, tj. wydrąża gniazda nasienne, wydmuchuje pestki z wnętrza papryk oraz rozkrawa ją na części. W artykule omówiono wyniki badań rozkrawania papryk. Badania wykazały, że proces cięcia jest prawidłowy oraz nie zaobserwowano niekorzystnych zmian struktury.

Słowa kluczowe: automat wydrążająco-tnący, papryka, obróbka warzyw

1. Introduction

The seasonality of the bell pepper crops forces the processing enterprises to organize their production processes. They have to focus mainly on the minimization of the storage time. For this purpose, work to design a hollowing and cutting device in cooperation between "J.A.M. INOX PRODUKT" in Kalisz, Industrial Institute of Agricultural Engineering in Poznań and Poznan University of Technology, was undertaken, which allows obtaining cut bell peppers with removed cores and seeds. Within the design stag-

es virtual model was elaborated and afterward numerical simulations were conducted. Basing on the obtained results, physical prototype was built to perform laboratory and exploitation tests. Fig. 1 shows the hollowing and cutting device prototype for bell peppers. Its structure and used materials meet the food safety requirements [2, 5].

The process starts from drawing initially selected peppers by workers from a collection box. Afterward they place bell peppers into the conveyor belt's holding sockets and then bell peppers are transported to the processing units.

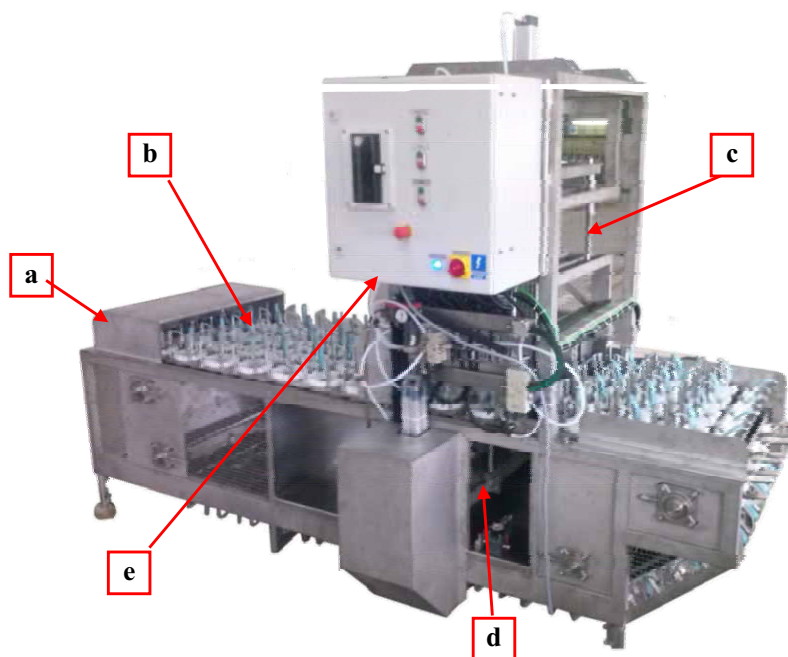


Fig. 1. General view of the hollowing and cutting device for bell pepper [3]: a) place for the collection box, b) conveyor belt with sockets, c) cutting unit, d) hollowing unit, e) control cabinet

Rys. 1. Widok ogólny automatu wydrążająco-tnącego do papryk [3]: a) miejsce na kosz zasypowy, b) taśma transportowa z umocowaniem produktu, c) zespół rozkrawania, d) zespół wydrążający, e) jednostka sterująca

During the hollowing stage, reciprocating crown-like-knives enter the bell peppers. Their backward movement removes core and seeds. Subsequently hollowed bell peppers are moved to the seeds removal unit where, by means of compressed air, seeds are being removed.

In the penultimate unit, cutting takes place. Downward movement of the cutting knife splits a bell pepper into required parts, depending on the number of cutting edges. This is the last processing stage fulfilled by the device.

In the finished product emptying stage the conveyor belt turns down and returns to the beginning of the device processing line. In this way processed bell peppers exit the conveyor belt sockets. The linear movement of conveyor belt is provided by electric drive unit whereas processing equipment is powered by usage of pneumatic drive. Both guarantee proven and reliable solution widely use in food industry machines [4].

2. The aim of the study

The aim of the laboratory tests, carried out in Industrial Institute of Agricultural Engineering in Department of Research and Development of Foodstuff Machinery and De-

vices was to estimate the regularity of the main hollowing and cutting device processing stages, estimate its performance and mark off the processing stages effectiveness. Within this paper merely part of obtained results are presented, principally cutting process testing.

3. Methodology research

Prior to the research, the bell peppers selection was carried out. Bell peppers were divided into three dimension groups according to its diameter (fig. 2).

The aim of the cutting stage tests was to estimate the effectiveness expressed by the proper cut bell peppers to whole peppers subjected to the test ratio. As a correct processed product assumed a bell pepper which parts were fully separated from each other and the pulp structure was not damaged. Tests were conducted using the computer image analysis with Motic microscope equipped with Bresser Mikrocam 9 Mpix camera.

During the tests, previously prepared bell peppers were placed into the conveyor belt holding sockets, which transported them under the cutting knives (fig. 3).

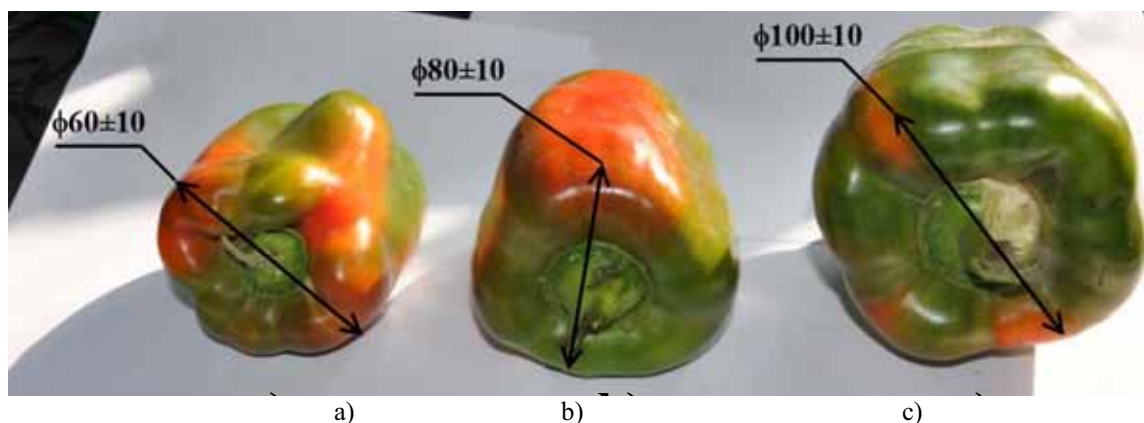


Fig. 2. Raw material for research divided into dimension groups: a) small, b) medium, c) large [1]
Rys. 2. Surowiec do badań podzielony na grupę papryki: a) małej, b) średniej i c) dużej [1]

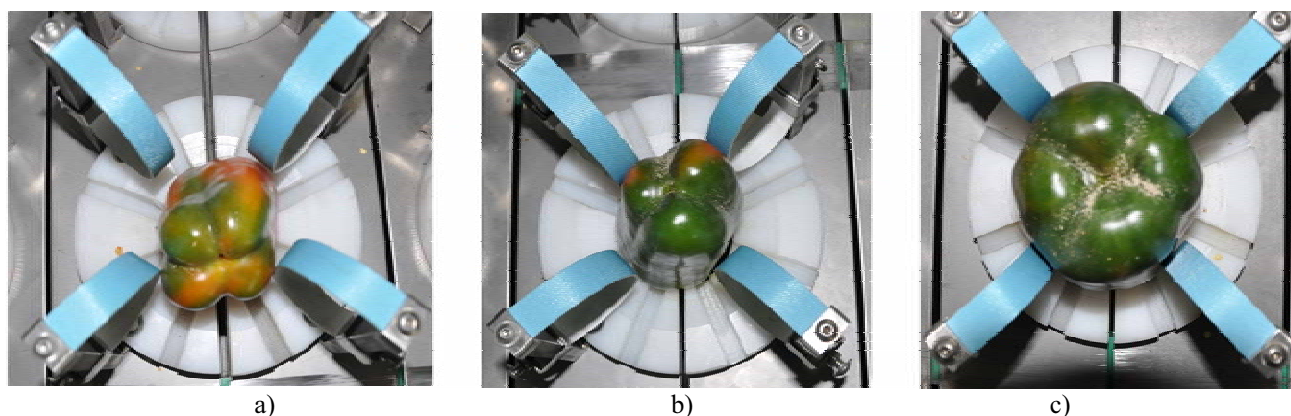


Fig. 3. The general view of bell peppers placed into conveyor belt holder sockets [1]: a) small pepper, b) medium pepper, c) large pepper
Rys. 3. Widok umocowania papryki w gniazdach taśmy transportowej automatu [1]: a) papryka mała, b) papryka średnia, c) papryka duża

Cutting knives, moving downward, were dividing bell peppers into required number of parts (fig. 4). As a result separated parts of bell peppers, prepared for next processing stages were obtained.

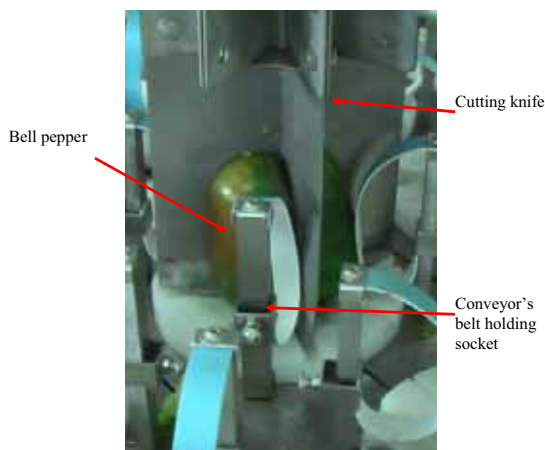


Fig. 4. The cutting knife used during the bell peppers cutting test [1]

Rys. 4. Nóż rozkrawający wykorzystany do badania cięcia papryki [1]

4. Results and discussion

Conducted research demonstrated that the hollowing and cutting device performance is 4000 bell peppers per hour. Appropriately selected bell peppers, divided into dimension groups and adjusted conveyor belt holding sockets gave high effectiveness of the processing stages. Exemplary graph, obtained by the cutting tests is shown in fig. 5.

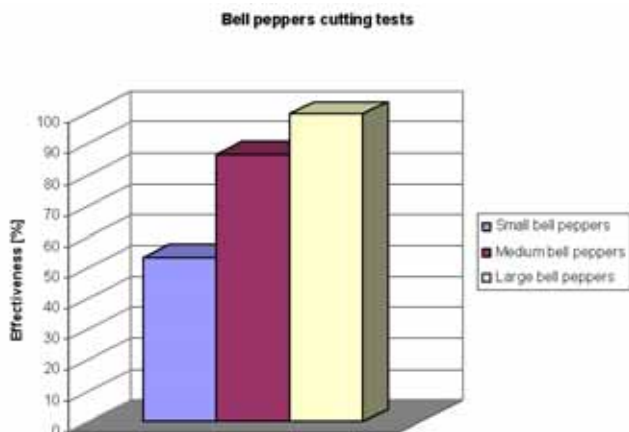


Fig. 5. The cutting process tests results [1]

Rys. 5. Wyniki procesu wydrążania papryk [1]

The best fitting, for each holding socket adjustment, was drawn for the large bell pepper group. For this group the effectiveness reached one hundred percent. The effectiveness up to 80% was recorded in medium group. In the case of small bell peppers, the inappropriate fitting in holding sockets resulted in the smallest effectiveness around 50%.

During the research it was diagnosed that positioning of the small and medium bell peppers in the conveyor belt holding sockets was incorrect, which contributed to higher amount of faultily cut bell peppers.

The hollowing and cutting device for bell peppers enables to adjust the holding sockets to each dimension group and finally eliminate the undesirable apparition.

In fig. 6 appropriate cut bell pepper is shown. The vegetable was separated into parts longwise direction.



Fig. 6. Example of appropriate cut bell pepper [1]

Rys. 6. Przykład papryki poprawnie rozkrojonej [1]

In fig. 7 an example of inappropriate cut bell pepper is presented. It can be seen that parts are not fully separated from each other and its side surface is damaged.

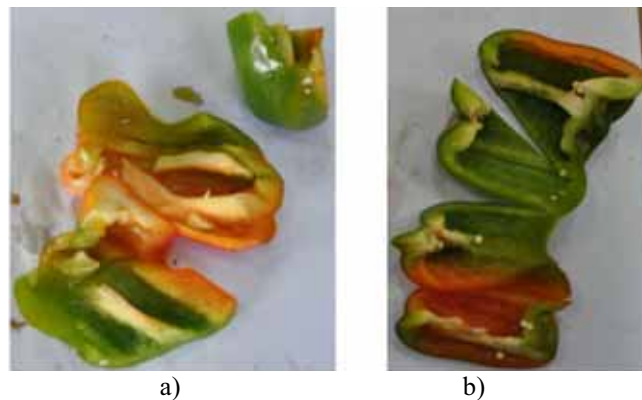


Fig. 7. Examples of the inappropriate cut bell peppers [1]
a) medium bell pepper cut in non-longwise direction,
b) small bell pepper with not fully separated parts and cut in non-longwise direction

Rys. 7. Przykłady niepoprawnie rozkrojonych papryk [1]:
a) średnia papryka rozkrojona wzdłuż niecałej długości,
b) mała papryka rozkrojona ukośnie w stosunku do osi wzdłużnej równoległej do dłuższego boku

The tests of the bell peppers pulp structure after cutting were also conducted. It was shown, by means of computer image analysis, that the cutting process does not damage pulp structure (fig. 8). No crushed areas and torn parts along a cutting plane were identified.

5. Conclusions

The hollowing and cutting device prototype tests, which is adapted to work in a technological line, allowed to estimate its performance around 4000 pieces per hour. Furthermore cutting process tests showed that the bell pepper's size and shape has a great influence on the effectiveness. For the large bell pepper dimension group, due to appropriate fitting between holding sockets and bell peppers, the cutting process effectiveness reached one hundred percent.

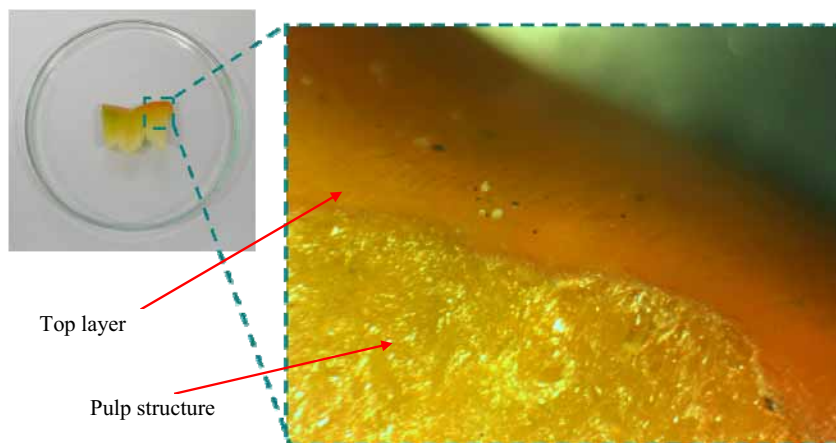


Fig. 8. The cross section of a bell pepper specimen [1]

Rys. 8. Przekroje wybranych próbek [1]

It has to be stated that suitable positioning of bell peppers in the sockets during the processing stages determined its effectiveness. In addition, basing on the computer image analysis, it was shown that correctly performed cutting process does not damage the bell peppers pulp structure

6. References

- [1] Bieńczak A., Dembicki D., Dudziński P., Marcinkiewicz J., Szczepaniak J.: Sprawozdanie z realizacji zadania nr 11 wg harmonogramu wykonania projektu celowego: „Opracowanie i wdrożenie do produkcji automatu wydrążająco-tnącego wchodzącego w skład linii technologicznej do obróbki papryki”. Tytuł zadania: „Badania laboratoryjne. Określenie maksymalnej wydajności automatu. Badania jakości wydrążania oraz cięcia”. Przemysłowy Instytut Maszyn Rolniczych, Poznań, 2013.
- [2] Dobrzański L.: Materiały inżynierskie i projektowanie materiałowe. Podstawy nauki o materiałach i metaloznawstwo. WNT, Warszawa, 2006.
- [3] Ignasiak Ł., Marcinkiewicz J., Szczepaniak J.: Sprawozdanie z realizacji zadania nr 5 wg harmonogramu wykonania projektu celowego: „Opracowanie i wdrożenie do produkcji automatu wydrążająco-tnącego wchodzącego w skład linii technologicznej do obróbki papryki”. Tytuł zadania: „Badania symulacyjne na modelu wirtualnym w zakresie zachowań kinematycznych, kolizji i detekcji elementów i zespołów roboczych”. Przemysłowy Instytut Maszyn Rolniczych, Poznań, 2013.
- [4] Branowski B.: Pod red. Podstawy konstrukcji napędów maszyn. Wyd. Politechniki Poznańskiej, Poznań, 2007.
- [5] Walas S. M.: Chemical Process Equipment - Selection and Design. Butterworths, Boston, 1988.