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ANALYSIS OF EXPENDITURES INCURRED WHILE ENSILING SUGAR BEET PULP

Summary

In the paper there are presented economic and material expenditures incurred during ensiling the sugar beet pulp in various forms of their storage: cylindrical bales wrapped with foil - ZPO, foil bag - ZWF and passage silo - ZSP. A computational algorithm was developed allowing determination of criterion indicators for which: fuel consumption, labor input and costs per unit weight of ensiled pulp was measured at actual humidity and expressed as the dry matter content. In addition, cost structure has been divided into costs of: machinery and equipment, fuels, labor and auxiliary materials. The highest total costs occur when bale were wrapped with ZPO foil and equal to 122,40 PLN·$Mg_{d.m.}^{-1}$ and are about twice as much as other ZWF technologies - 62.50 PLN·$Mg_{d.m.}^{-1}$ and ZSP - 64,60 PLN·$Mg_{d.m.}^{-1}$. Costs associated with auxiliary materials, which are the largest in the case of ZPO technology, amount of 65.30 PLN·$Mg_{d.m.}^{-1}$, then ZSP – 47,80 PLN·$Mg_{d.m.}^{-1}$, and the smallest were in ZWF technology equal to 29.80 PLN·$Mg_{d.m.}^{-1}$.

***Key words**: sugar beet pulp, storage, ensiling, testing, fuel consumption, labor consumption, costs, analysis*

ANALIZA NAKŁADÓW PONOSZONYCH PRZY ZAKISZANIU WYSŁODKÓW BURACZANYCH

Streszczenie

W pracy zostały określone nakłady ekonomiczne oraz materiałowe ponoszone przy zakiszaniu wysłodków burczanych przy różnych formach ich składowania: bele cylindryczne owinięte folią- ZPO, worek foliowy – ZWF oraz silos przejazdowy – ZSP. Opracowano algorytm obliczeniowy, który pozwolił na wyznaczenie wskaźników kryterialnych, za które przyjęto: zużycie paliwa, nakłady robocizny oraz koszty odniesione do jednostki masy zakiszanych wysłodków przy rzeczywistej wilgotności i w przeliczeniu na masę suchej substancji. Ponadto opracowano strukturę kosztów z podziałem na koszty: maszyn i urządzeń, paliwa, robocizny oraz materiałów pomocniczych. Największe koszty całkowite występują przy zakiszaniu wysłodków w belach owiniętych folią ZPO wynoszące 122,40 zł·$Mg_{s.m.}^{-1}$ i są około dwukrotnie większe w porównaniu do pozostałych technologii ZWF – 62,50 zł·$Mg_{s.m.}^{-1}$ oraz ZSP – 64,60 zł·$Mg_{s.m.}^{-1}$. W strukturze kosztów we wszystkich technologiach dominują koszty związane z materiałami pomocniczymi, które są największe w przypadku technologii ZPO wynoszące 65,30 zł·$Mg_{s.m.}^{-1}$, następnie ZSP – 47,80 zł·$Mg_{s.m.}^{-1}$, a najmniejsze w technologii ZWF równe 29,80 zł·$Mg_{s.m.}^{-1}$.

***Słowa kluczowe**: wysłodki buraczane, składowanie, zakiszanie, badania, zużycie paliwa, pracochłonność, koszty, analiza*

1. Introduction

Rising energy prices cause the costs of animal feeding to increase steadily. Farmers, more and more often than in the preparation of silage from plant materials available on their own farms, use products derived from food processing plants. These products include pressed sugar beet pulp, which, after ensiling, provides high quality feed for all-year feeding of dairy cattle, fattening cattle, pigs and sheep [1, 7, 8, 20, 24].

The competitiveness of pressed sugar beet pulp compared to other bulk feeds is due to its high nutritional value - 0.22 JPM (milk food unit) and over 11 MJ· $kg_{d.m.}^{-1}$ metabolic energy [1]. Values of these parameters are comparable to the easier to use dried beet pulp, but drying requires much more economic expenditure [2].

Beet pulp is most commonly used in passage silo, in addition on the bottom plate and gutter there is silage juice tank. Besides that there are additional monolithic concrete side walls with a height of about 2 m and a width of 6 to 10 m [14, 15, 16]. In practice, open silos are the most commonly encountered, but for ensilaging beet pulp covered silos are preferred [5, 15]. When filling the silos it is important to organize the work so that it takes place the shortest possible time. Similarly to the maintenance of other vegetable materials, it is important that the silo material is properly and evenly compacted before ensiling, as well as sealed with foil, some soil, worn tires and an additional protective mesh [10, 21, 24].

For reliable and efficient preserving pressed sugar beet pulp it is stored in sealed plastic bags using silo presses [3, 4, 6, 19]. Significant size range of bags with a diameter of 2.4; 2.7; or 3 m and length of 45; 60; 75 m (eg AG BAG) - allows you to select a bag with capacity adapted to the size of the stocked animals, also reduce the losses of ensilaged pulp during feeding, and furthermore it ensures good storage conditions and silage stability [2, 3] . In the foil bag should not be present sugar beet pulp with a dry matter content of less than 18%, because in case of too much moisture it can't be sufficiently pressed, and fermentation processes occur in the silage, what produces excessive amounts of gases emitted in the first days and this may cause bag damage [24]. It has been shown that silages made in foil bags give better properties than those stored in passage silos [6, 19]. This way of storing beet pulp is mainly applied in large farms specialized in animal production.

Therefore, an alternative way to preserve pulp consists in the use of special press machines, which have both organizational and utility benefits [7, 8, 9, 18]. Currently on the

market several manufacturers such as Norwegian Orkel, Austrian Göweil and Japanese Takakita have in their offer this type of baling press [18]. Machinery of the first two companies are already utilized in Poland. They allow formation of cylindrical bales and wrap them with self-adhesive foil, which protects the compressed material from air access. Silages made using these machines are characterized by high quality and the bales are prepared in relatively small size what makes easy for their transportation, and significantly increases their use as in animal production [8, 9]. This way of pulp preservation has been implemented for a long time in agricultural practice in Austria and Switzerland [1, 22, 18, 23], and for a few years also in Poland [2, 7, 8, 9].

The purpose of this paper is to determine the value of material and economic inputs spent on the sugar beet pulp ensiling and its evaluation in the light of costs incurred when using the silo bag and in case of utilization of passage silo.

2. Material and methods

When determining the economic and material inputs to be provided in ensiling of sugar beet pulp in different ways of storing them, three technologies were analyzed to observe this process:

- pressed pulp in the form of cylindrical bale wrapped with self-adhesive foil (drive of the main machine from the PTO of the farm tractor) - marked ZPO,
- pulp stored in foil bag using silo press - ZWF,
- pulp stored in a concrete passage silo - ZSP.

The first technology for baling and wrapping cylindrical bales at a diameter of 1.15 m and a length of 1.20 m, utilizes the Orkel MP2000 Compactor. The NH T7.210 agricultural tractor was used to drive the machine using PTO system. The pressed bales were "mesh-bound" and then wrapped with a 0.025 mm thick self-adhesive foil. The transport of bales wrapped in foil to the storage place was carried out using a JCB 530-60 telescopic loader equipped with a cylindrical bale loader system.

In the ZWF technology, sugar beet pulp directly from the transport means was loaded into the hopper of the AG-BAG G6700 silo press (driven by the PTO farm tractor NH T7.210), which delivers it into the foil bag.

In the case of the latest technology (ZSP), the pulp from the transport trailers was discharged to the passage silo, where the NH T7.210 farm tractor fitted with a Quicke Q46 front loader and a shovel distributed the material on the storage surface and moved thereafter until the required compaction was achieved. The operation ended with providing silo cover with foil and using proper loads.

The following criteria were used to evaluate the methods of preserving sugar beet pulp:

– fuel consumption: $dm^3 \cdot Mg_{d.m.}^{-1}$,
– value of labor inputs: $rbh \cdot Mg_{d.m.}^{-1}$,
– the cost of operating machines and devices used for ensiling: $PLN \cdot Mg_{d.m.}^{-1}$.

Calculations of unitary operating expenditures and costs incurred in individual technologies of ensiling sugar beet pulp were executed using developed computer program [2]. At this point we have utilized the elements of methodological studies [17] and theoretical analyzes conducted at the Department of Agricultural Machinery and Forestry [4, 10, 11, 12, 13].

Operating costs (hourly) are defined as the total cost of maintenance of tractors and machinery and their use. The total cost of maintaining tractors and machinery in the year includes the sum of depreciation, storage and insurance costs, and after taking into account the number of hours they are used in the year, we get hourly maintenance costs.

In turn, the costs of using result from the use of tractors and machinery in the production process, i.e. their use in ensilaging of beet pulp and include: repair costs, fuel and lubricant costs, costs of auxiliary materials as well as labor costs for one hour of work.

Machinery costs include the cost of buying and repairing machines.

The cost of auxiliary materials (net for bales wrapping, foil bags, silos bag and foil cover the silo prisms) was determined by multiplication of the product use and the unit price.

The unitary costs of beet pulp ensilaging in terms of their weight were determined by hourly operating costs and mass yields for the actual moisture content of the pulp and expressed as the dry matter content. For calculations, the value of 25% was taken as the dry matter content of sugar beet pulp.

In the case of a new technology, technological research was carried out in production conditions during the sugar beet campaign at Werbkowice Sugar Plant. Orkel MP2000 Compactor (Fig. 1 a) and JCB 530-60 telescopic loader (Fig. 1b) were tested on the basis of industry standards BN-77 / 9195-02 and BN-76 / 9195-01.

a)

b)

Source: own materials / Źródło: materiały własne

Fig. 1. Loading sugar beet pulp: a - directly from the feeder of the sugar factory line to the hopper of the preheater; b - using telescopic loader with gripper to cylindrical bales
Rys. 1. Załadunek wysłodków buraczanych: a – bezpośrednio z podajnika linii technologicznej cukrowni do kosza zasypowego prasoowijarki; b – za pomocą ładowarki teleskopowej z chwytakiem do cylindrycznych bel

Table 1. Basic technical and operational parameters and prices of machinery and equipment adopted in the calculation
Tab. 1. Podstawowe parametry techniczno-eksploatacyjne i ceny maszyn i urządzeń przyjętych w obliczeniach

No.	Name of machinery	Power kW	Min. power requirement kW	Efficiency $Mg \cdot h^{-1}$	Price of purchase PLN
1.	Tractor NH T7.210	122	-	-	370 200
2.	Telescopic loader JCB 530 – 60	90	-	-	254 000
3.	Press-wrapper Orkel MP2000 Compactor	-	90	48-60	990 000
4.	Silo-press AG-BAG G6700	-	55-92	25-70	237 120
5.	Front-loader Quicke Q46	-	45-75	-	32 800

Source: own work / Źródło: opracowanie własne

Provided detailed work concerning timing to determine the execution times of individual operations to determine the performance indicators needed further calculations. Fuel consumption was determined by the full tank method. The moisture content of the pressed pulp was 25% and was the same for all other technologies.

The basic technical parameters and purchase prices of the tractor, agriculture machinery and equipment utilized in the experiment are presented in Table 1.

Prices of fuel and auxiliary materials were adopted in accordance with the last quarter of 2015: the price of roll net was equal to 130 cm x 3800 m - 590 PLN, the roll of foil 750 mm x 1500 m and thickness 0.025 mm was equal to 300 PLN, the price of foil bag 2.4 x 60m - 1470 PLN, price of silage film 8 x 33m - 620 PLN [2].

3. Results and discussion

Calculated values of labor, energy inputs and costs were referred to the unitary mass of the sugar beet pulp humidity and calculated on the weight of substance and are summarized in Table 2.

As it can be seen, the highest consumption of fuel is characterized by technology of silage sugar beet pulp called ZPO and equal to 1.31 $dm^3 \cdot Mg_{d.m.}^{-1}$. In this technology, silage is achieved by using a stationary rotary tiller driven by a tractor PTO system. Transport wrapped bale with foil to the storage place is carried out using telescopic loader. Relatively small portions of sugar beet pulp are often required to bale the net with bale and foil and then transportation to a storage location, which results in high fuel consumption over other technologies. At the same time, the smallest fuel consumption of 0.84 $dm^3 \cdot Mg_{d.m.}^{-1}$ is characterized by the technology of silage sugar beet pulp in the passage silo, where the raw material is compacted by the weight of the tractor.

Similarly, the first analyzed ZPO technology, in which the pulp is stored in cylindrical bales (ZPO - 0.41 $rbh \cdot Mg_{d.m.}^{-1}$) is characterized by the highest labor intensity. This technology requires the involvement of at least two people to operate the wrapper, as well as the operator of the loader lifting the bales to the temporary storage site. On the other hand, the smallest labor inputs were recorded in case of sugar beet pulp ensilaging in long film bag ZWF (0.29 $rbh \cdot Mg_{d.m.}^{-1}$).

The high capacity of the foil bags allows for efficient filling, for a long period of time, without having to stop work, which in turn has a positive effect on reducing the labor intensity of the technology. A slightly higher labor input was noted in the ZSP technology (0.32 $rbh \cdot Mg_{d.m.}^{-1}$) where the pulp is stored in a passage silo. In addition this is taken into account to the workload of the operator who works on tractor with the bulldozer and press machine, and also the costs occurred for cover of the prism with foil and additional loads.

As can be seen, the total cost of ensiling of sugar beet pulp in ZPO wrapped bales - 122,40 $PLN \cdot Mg_{d.m.}^{-1}$ is almost twice as high as the other ZWF technologies - 62.50 $PLN \cdot Mg_{d.m.}^{-1}$ and ZSP - 64,60 $PLN \cdot Mg_{d.m.}^{-1}$.

Table 2. Unitary cost for various sugar beet pulp preservation technologies with respect to their weight at actual humidity and expressed as the dry substance content
Tab. 2. Wartości jednostkowych nakładów ponoszonych w różnych technologiach zakiszania wysłodków buraczanych w odniesieniu do ich masy przy rzeczywistej wilgotności i w przeliczeniu na masę suchej substancji

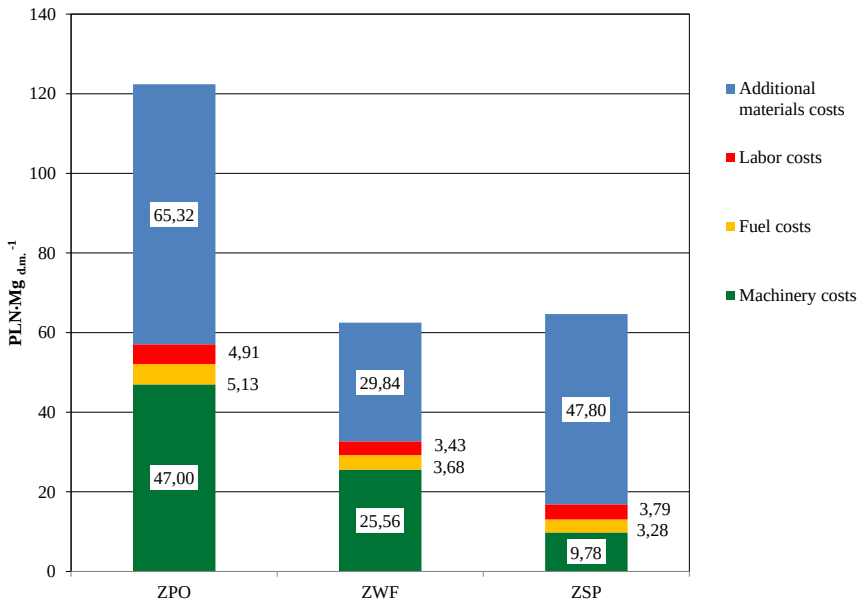
Specification	Units	Technology		
		ZPO	ZWF	ZSP
Fuel consumption	$dm^3 \cdot Mg^{-1}$	0,33	0,24	0,21
	$dm^3 \cdot Mg_{d.m.}^{-1}$	1,31	0,94	0,84
Labour input	$rbh \cdot Mg^{-1}$	0,10	0,07	0,08
	$rbh \cdot Mg_{d.m.}^{-1}$	0,41	0,29	0,32
Costs	$PLN \cdot Mg^{-1}$	30,60	15,60	16,20
	$PLN \cdot Mg_{d.m.}^{-1}$	122,40	62,50	64,60

Source: own work / Źródło: opracowanie własne

Figure 2 illustrates the total costs incurred for preservation of sugar beet pulp using different technologies, taking into account the costs of utilized machinery, fuel consumption, labor input and auxiliary materials.

The main component of unitary costs are costs associated with auxiliary materials. In the case of ZPO technology it is as much as 65.30 $PLN \cdot Mg_{d.m.}^{-1}$, which consists of the cost of the net used and bales of foil, which account for more than 50% of total costs. The high share of costs of auxiliary materials also occurs in case of silage from sugar beet pulp in ZSP silo - 47.80 $PLN \cdot Mg_{d.m.}^{-1}$, which is affected by the high cost of silos and accounts for more than 70% of total costs. The lowest component costs of this type occur in the ZWF technology, resulting from the purchase of foil bag and amount to 29.80 $PLN \cdot Mg_{d.m.}^{-1}$, which accounts for about 48% of total costs.

In the next step, the cost of utilized machinery and equipment is significantly affected by the overall cost structure. In the case of ZPO sugar beet pulp technology, their value is the highest and is equal to 47.0 $PLN \cdot Mg_{d.m.}^{-1}$, which is due to the high purchase price of the main machine, which is a press-wrapper (38% of total costs). In the case of ZWF technology, these costs are equal to 25.60 $PLN \cdot Mg_{d.m.}^{-1}$ (41%), and the smallest are in the silo at the ZSP silo and are only 9.80 $PLN \cdot Mg_{d.m.}^{-1}$ (16%). Tractor with loader was utilized for spreading and pressing sugar beet pulp in the silo.



Source: own work / Źródło: opracowanie własne

Fig. 2. Unitary cost structure for the analyzed technology of sugar beet pulp preservation considering the share of costs of utilized machinery, fuel consumption, labor input and auxiliary materials

Rys. 2. Struktura kosztów jednostkowych dla analizowanych technologii zakiszania wysłodków buraczanych z uwzględnieniem udziału kosztów zastosowanych maszyn, zużytego paliwa, nakładów robocizny i materiałów pomocniczych

4. Conclusions

1. The analysis shows that the different technologies characterize the different values of material and economic inputs, which were adopted as criterion indicators.
2. The highest fuel consumption is characterized by ZP press-wrapper technology of 1.31 $dm^3 \cdot Mg_{d.m.}^{-1}$, and technology of sugar beet pulp silage in ZSP silo - 0.84 $dm^3 \cdot Mg_{d.m.}^{-1}$ gives the smallest fuel consumption. The highest among the analyzed values of fuel consumption in ZPO technology is explained by the need to use an additional machine, ie. a telescopic loader to remove and stack wrapped bales in the square.
3. The largest labor inputs are in ZPO technology of 0.41 $rbh \cdot Mg_{d.m.}^{-1}$, and the smallest in the case of sugar beet pulp in long film bag ZWF equal to 0.29 $rbh \cdot Mg_{d.m.}^{-1}$. Indirect labor cost values were determined for the ZSP technology of 0.32 $rbh \cdot Mg_{d.m.}^{-1}$, due to the need to take into account not only the workload of the operator of the tractor with the bulldozer and press machine, but also the costs incurred for covering of the foil and to put the loads.
4. The analysis of unitary costs shows that the greatest occur with silage in bales wrapped with ZPO foil and are equal to 122,40 $PLN \cdot Mg_{d.m.}^{-1}$ and are twice as large as in other technologies ZWF - 62.50 $PLN \cdot Mg_{d.m.}^{-1}$ and ZSP - 64,60 $PLN \cdot Mg_{d.m.}^{-1}$.
5. An analysis of cost structure taking into account the costs of utilized machinery, fuel consumption, labor input and auxiliary materials shows that the costs associated with auxiliary materials dominate in all technologies. In the case of ZPO technology they amount to as much as 65.30 $PLN \cdot Mg_{d.m.}^{-1}$, and the smallest costs are in technology ZWF-29.80 $PLN \cdot Mg_{d.m.}^{-1}$. Indirect costs of auxiliary materials are available in ZSP technology - 47,80 · $PLN \cdot Mg_{d.m.}^{-1}$, which is influenced by the high cost of silo construction.
6. The cost of utilized machinery and equipment is the largest for ZPF technology, and amounts of 47.0 $PLN \cdot Mg_{d.m.}^{-1}$, significantly lower result from this technology is characterized by ZWF technology - 25.60 $PLN \cdot Mg_{d.m.}^{-1}$ and the smallest cost of machinery is presented by technology ZSP 9.80 $PLN \cdot Mg_{d.m.}^{-1}$.
7. Overall assessment of the value of specific criteria indicators is not difficult to see that the highest values apply to technology with press-wrapper machine - ZPO. However, this does not mean that it is a negative assessment and there is no prospect of its application in practice. The effect of high quality feed, without loss, in small portions, allowing them to distribute and provide easy transport to the chosen place is an argument supporting its systematic implementation in practice in our country. This technology can be used in livestock production with a varied stock size.

5. References

[1] Abramczuk W., Spychała W.: Wysłodki buraczane – produkt uboczny w produkcji cukru, a jednocześnie doskonała i wartościowa pasza. Burak Cukrowy, 2009, 4: 17-21.
[2] Biedrzycki K.: Nakłady materiałowe i ekonomiczne ponoszone przy zakiszaniu wysłodków buraczanych. Praca magisterska. WIP, SGGW 2016.
[3] Chlebowski J., Gach S., Kowalski P.: Analiza możliwości zakiszania surowców roślinnych w rękawach foliowych. Technika Rolnicza Ogrodnicza Leśna, 2006, 9-10: 16-20.
[4] Chlebowski J., Gach S., Gozdalik I., Kowalski P.: Analiza nakładów ponoszonych na zbiór i zakiszanie ziarna kukurydzy. Inżynieria Rolnicza, 2008, 1: 71-76.
[5] Clark S., Stone R.P.: How to handle seepage from farm silos, fact-sheet. ministry of agriculture, food and rural affairs. Ontario, Canada 2004.
[6] Csermley J., Bellus Z., Hedrovics M., Komka GY., Schmidt J., Sipöcz J.: Fodder preservation by fermentation in plastic bags. Hung. Agricult. Eng., 2000, 13.
[7] Dulcet E. Ledóchowski P.: Technologia zakiszania wysłodków buraczanych w postaci bel cylindrycznych owiniętych folią. Journal of Research and Applications in Agricultural Engineering, 2007, Vol. 52 (3): 37-39.

[8] Dulcet E., Kaszkowiak J., Ledochowski P.: Zakiszanie wysłodków buraczanych w belach cylindrycznych. Inżynieria Rolnicza, 2008, 4 (102): 241-248.
[9] Dulcet E., Dorszewski P., Kaszkowiak J., Borowski P., Rama R., Bujaczek R.I., Chojnacki J.: Analiza jakości kiszonek z wysłodków buraczanych sporządzonych przy użyciu prasy zwijającej do materiałów rozdrobnionych. Acta Sci. Pol., Technica Agraria, 2011, 10 (3-4): 19-26.
[10] Gach S., Kowalski P.: Technologiczne i metodyczne aspekty składowania i zakiszania rozdrobnionych roślin kukurydzy. Postępy Nauk Rolniczych, 2010, 1: 101-108.
[11] Gach S., Piotrowska E., Skonieczny I.: Foil consumption in wrapping of the single green forage bales. Annals of Warsaw Agricultural University of Life Sciences - SGGW Agriculture, 2010, 56: 13-20.
[12] Gach S., Korpysz K., Polańczyk M.: Nakłady ponoszone na zbiór i zakiszanie ziarna kukurydzy w worku foliowym. Journal of Research and Applications in Agricultural Engineering, 2011, Vol. 56 (2): 44-48.
[13] Gach S., Ivanovs S., Barwicki J., Karwowski B.: Expenditure for harvesting and ensiling of low stalk green fodder using press and pickup trailer. Journal of Research and Applications in Agricultural Engineering, 2016, Vol. 61 (2): 21-25.
[14] Gancarz F., Rasmussen J.B.: Standardy dla gospodarstw rolnych w zakresie produkcji i magazynowania kiszonek. Wieś Jutra, 2003, 11(64): 33-35.
[15] Kobielak S., Hutnik E., Mulica E.: Analiza rozwiązań poziomych silosów na kiszonki. Problemy Inżynierii Rolniczej, 2010, 2: 51-64.
[16] Majchrzak M.: Innowacyjne rozwiązania magazynowania i pobierania pasz objętościowych. ITP Warszawa 2014.
[17] Muzalewski A.: Koszty eksploatacji maszyn. Wskaźniki eksploatacyjno-ekonomiczne maszyn i ciągników rolniczych stosowanych w gospodarstwach indywidualnych. Wydawnictwo ITP Falenty 2010.
[18] Nowak J.: Maszyny do formowania bel cylindrycznych. Wydawnictwo Uniwersytetu Przyrodniczego w Lublinie 2013.
[19] Podkówka W., Podkówka L., Cermak B., Podkówka Z.: Jakość i wartość pokarmowa kiszonek sporządzonych w rękawie foliowym. Materiały konferencji: Gospodarowanie na użytkach zielonych w warunkach rolnictwa integrowanego. IMUZ, Falenty 1999.
[20] Warych H.A.: Kiszonka z prasowanych wysłodków buraczanych dobrym komponentem dawek dla krów. Przegląd Hodowlany, 2007, 7: 12-13.
[21] Winnicki S., Domagalski Z., Pleskot R.: Technika w zakresie konserwacji przechowywania i zadawania pasz dla bydła. Ekspertyza IBMER Poznań 2009.
[22] Wyss U.: Silierung von Apfel und ein Birnentrester. Agrarforschung, 2003, 10 (3): 104-109.
[23] Wyss U., Metthez C.: Sugar beet pulp with higher DM-contents shows a good silage quality. Agrarforschung, 2014, 5 (04): 146-153.
[24] Żurawska M., Abramczuk W.: Nowoczesne sposoby konserwacji wysłodków prasowanych. Konferencja STC. Postęp w uprawie buraków i w gospodarce surowcowej, Toruń 2010.