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APPLICATION OF THE COLD STAMPING METHOD FOR RAPESEED OIL EXTRACTION

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Summary. The report presents the results of research on determining the amount of oil that can be obtained by the method of single- stage rapeseed varieties stamping. Furthermore, after taking into account rapeseed varieties harvesting, the amount of oil that can be obtained from the cultivation area of 1 hectare was established. After examining fourteen different varieties, it was found that the difference in oil output was 14%. Within the same variety, cultivated in several different places, the difference reached 32%. Relatively, from 1 hectare of culture 1158 kg (1288 dm^3) to 1592 kg (1760 dm^3) was obtained, which indicates that the most favorable variety can give out about 37% more oil than the least favorable one.

Key words: rape oil, biofuel

INTRODUCTION

One of the most important tendencies for engine construction development is a reduction in carbon dioxide emission to the atmosphere and, consequently, limitation of greenhouse effect. Improvement of carbon dioxide balance can be achieved, among other means, by alternative fuels application. I mean fuels of plant origin, regarding carbon dioxide closed circulation. For self-ignition engines, such fuel can be rapeseed oil Methyl Ester – biodiesel FAME. This fuel is based on rapeseed oil. Nowadays, a lot of rapeseed varieties are harvested, and more than thirty varieties are harvested in Poland. The number of different varieties is the cause why we obtain oil of many different physical and chemical characteristics depending on the variety. This causes the need to select those varieties that give out the biggest amounts of oil, with the best characteristics, regarding oil usefulness for biofuels.

Appropriate research with an aim to indicate to farmers and biofuels producers which varieties are the most attractive, with respect to crop profitability and the amount of oil that can be obtained, should be carried out. In the same time, this oil should possess good physical and chemical characteristics, such as required fatty acid composition, high heat value etc. For this reason, the author of this report has undertaken this study.

OBJECTIVE AND SCOPE OF RESEARCH

One of the aims of the research was to determine the volume and mass amount of oil that can be obtained in the process of single-stage, cold stamping. Subsequently, on the basis of data on cultivar yielding, potential total quantities of oil (rapeseed fuel) have been determined, which may be produced per cropped area.

Tests were carried on fourteen winter rapeseed varieties, cultivated by a single farmer. Additionally, tests were carried out on the single variety Lisek, cultivated by five different farmers.

Fourteen different rapeseed varieties were obtained in cooperation with OBROL Kulczyński Sp. J. Company. Crop quantity was quoted according to OBROL Kulczyński Sp. J. Company data and annual rapeseed varieties crop statistics given by COBORU Publishing Company [Heimann 2002a, b]. As a harvest quantity, an average from 2001-2003 was taken.

With the purpose to examine the influence of culture conditions (weather-soil conditions, cultivation technology standards etc.) on the rapeseed ability to give out oil in the stamping process, testing was done on several rapeseed samples, Lisek variety. Samples were delivered by farmers from three different sites and three different provinces. The results of research were compared with the results obtained for Lisek variety – cultivated in Wielkopolska, which allowed for comparison of rapeseed cultivation in five sites. Real crop, harvested by farmers was used for calculation.

The amount of cultivar yields is only indicatory since each year the amount changes depending on such factors as: level of cultivation technologies, conditions of over wintering, precipitation during growing season and disease threat.

METHODS

Rapeseed oil was obtained by the method of single-stage cold stamping (without extraction). The stamping-press used was produced by the Czech Republic Company Farmet. A photograph of the oil press may be seen in Figure 1.

Fig. 1. Stamping-press produced by Farmet Company from Czech Republic, type Farmet Uno

DETERMINATION OF OIL PER 1KG OF RAPESEED AMOUNT BY MASS AND VOLUME

The chapter presents the results of research on the amount of oil which can be obtained from pressing many different types of rapeseed. The obtained amounts of oil are approximate numbers and should be associated with the applied method and the oil press. The results can be different in case of using the same method but an oil press of a different producer. It is also possible that in the case of applying the method of hot pressing, the correlation between the obtained amounts of oil can be different. Table 1 presents mass and volume of rapeseed oil obtained directly after pressing and filtering.

Table 1 displays mass and volume shares of rapeseed oils obtained from fourteen varieties harvested in Wielkopolska.

Table 1. Percentage by mass and volume and density of rapeseed oil

Rapeseed cultivar	Oil mass (after pressing) g/kg seeds	Oil volume (after pressing) ml/kg seeds	Gęstość oleju kg/dm^3*
Kaszub	340	386	0.88
Mazur	305	342	0.89
Pomorzanin	335	376	0.89
Amor	353	392	0.90
Bazyl	310	344	0.90
Cazek	329	374	0.88
Californium	338	380	0.89
Kana	389	437	0.88
Libomir	345	388	0.89
Liclassic	353	392	0.90
Lirajet	275	306	0.90
Lisek	347	390	0.89
Rafaela	335	372	0.90
Rasmus	336	373	0.90

*Oil density determined at 15^{o}C according to Polish Standard PN-86/C-04062

Table 1 shows that the biggest amount of oil according to the mass – 389 g was obtained from pressing 1 kg of rapeseed variety Kana. This variety was the only one to give over 380 g of oil. Comparatively big quantities of oil – over 350 g –were obtained from such varieties as: Amor and Liclassic. The smallest amount, 275 g, was obtained from pressing variety Lirajet. Half of the tested varieties gave amounts of oil ranging between 330 and 350 g. This indicates that the difference in oil output between the most favorable variety Kana and the least favorable Lirajet is 41%. A similar difference in oil quantity had been established by the author of this report in a series of tests carried out a year earlier. At that time, fifteen winter varieties were tested and the most favorable variety gave 33% more oil than the least favorable one [Szlachta 2002]. Those tests were carried out by another stamping-press, produced by the German Company Komet, sym-

bol CA-59G. Comparing the research results obtained by the use of these two stamping-presses, Czech and German, we can say that in general, more oil was obtained by the Czech stamping-press.

By volume (after filtering – Table 1) the biggest quantities of oil, almost 437 ml were obtained from 1kg of rapeseed, Kana c.v., whereas the least, 306 ml, from Lirajet variety. The above comparison demonstrates that by volume it is possible to obtain 42% more oil from Kana, c.v. than from Lirajet c.v.

Fairly large quantities of oil, exceeding 380 ml were obtained also from 1kg of seeds of the following cultivars: Amor, Liclassic, Lisek, Libomir, Kaszub and Californium. Oil yield from the other cultivars ranged between 342 and 376 ml.

At a further stage of research, influence of climate-soil and cultivation technology standards on rapeseed draw ability – an ability to give out oil in the process of stamping – was estimated. Tests were carried out on a winter variety Lisek. Rape was harvested in five different sites and in three provinces. Rape was cultivated in different climate-soil conditions, the cultivation technology standards were also different. The results (Table 2) should nevertheless be interesting, since they refer to real culture conditions

Table 2. Mass, volume shares and density of rapeseed oils, obtained from Lisek variety, cultivated in different sites

Cultivation site (province, site)	Oil mass (after pressing) g/kg seeds	Oil volume (after pressing) cm^3/kg seeds	Gęstość oleju kg/dm^3 *
Wielkopolskie – Kruszewnia	347	390	0.89
Śląskie – Dankowice	285	317	0.90
Dolnośląskie – Ząbkowice Śl.	323	359	0.90
Małopolskie – Węgrzce	266	296	0.90
Małopolskie – Zagórze	351	394	0.89

* Oil density determined at 15°C according to Polish Standard PN-86/C-04062

Table 2 indicates that the biggest mass of oil – 351 g was obtained from 1kg of rapeseed variety Lisek, harvested from site Zagórze in Małopolska province. The smallest amount of oil – 266 g, was obtained from the same variety, cultivated also in Małopolska in site Węgrzce. This demonstrates the difference in amount of oil obtained from Lisek cultivated in Zagórze in comparison to the same variety cultivated in Węgrzce is 32%. As the difference in density is small, about 1%, this correlation of oil output, stated in voluminal units, is approximately 33%. On the basis of this correlation we can see that weather-soil conditions and cultivation technology standards have, apart from the variety type, key influence on rapeseed draw ability. For the purpose of determining the amount of oil that can be obtained from a cultivation area, apart from the mass of oil obtained from rapeseed, harvesting of varieties should be taken into account.

DETERMINATION OF OIL QUANTITIES PER 1 HA OF RAPESEED CROPPED AREA BY MASS AND VOLUME

Sizes of the crops, used for the calculations, were given on the basis of the data obtained from OBROL Kulczyński Sp. J. and COBORU Publishing Company. Table 4 presents size of the crops obtained by particular farmers in the year 2004.

Table 3 presents counted oil amounts that can be obtained for different rapeseed varieties from a cultivation area of 1 hectare.

As may be seen from Table 3, the largest quantities of oil – 1592 kg – may be obtained per 1ha of winter rapeseed, Californium c.v. (the assumed yield 47.1 dt/ha), while the least amount – 1158 kg – from rapeseed Lirajet c.v. (the assumed yield 42.1 dt/ha). Comparatively big amounts of oil, more than 1500 kg can be obtained from such varieties as: Amor, Pomorzanin, Liclassic, Libomir, Kaszub. On the basis of Table 3 we can observe that in volume units, the biggest amount – 1790 dm^3 - can be obtained from 1 hectare of cultivation area of the variety type Californium. More than 1700 dm^3 can be obtained from the varieties: Kana, Amor, Pomorzanin, Kaszub, Libomir, Liclassic and Lisek.

Table 3. Amount of oil that can be obtained from cultivation area of 1 hectare

Rapeseed cultivar	Yield dt/ha	Oil mass kg/ha	Oil volume dm^3/ha
Kaszub	45.5	1547	1756
Mazur	45.9	1400	1570
Pomorzanin	46.8	1568	1760
Amor	44.9	1585	1760
Bazyl	43.0	1333	1479
Cazek	44.2	1454	1653
Californium	47.1	1592	1790
Kana	40.5	1559	1770
Libomir	45.0	1552	1746
Liclassic	44.0	1553	1725
Lirajet	42.1	1158	1288
Lisek	44.1	1530	1720
Rafaela	41.5	1390	1544
Rasmus	44.0	1478	1641

This is a very big amount of oil, in the same time, similar oil amount value was obtained in tests carried out in 2003. Those tests were carried out by the use of a different stamping-press. The stamping-press used was produced by the German Company Komet CA-59G. At that time 1748 dm^3 was obtained from winter variety Digger [Wcisło 2004].

This indicates that the difference in oil output between the most favorable variety Californium and the least favorable Lirajet is about 38%. As we can see on the basis of those calculations, the difference in oil quantity that can be obtained from a cultivation area can be very significant. This demonstrates how important is an appropriate choice

of varieties if we want to obtain the biggest amount of oil, to be used as a base for biodiesel FAME.

Another stage of research estimates the influence of climate-soil conditions and cultivation technology standards on oil amount that can be obtained from a cultivation area. Research was carried out on variety Lisek, the results were presented in Table 4.

Table 4. Amount of oil that can be obtained from cultivation area of 1 hectare

Rapeseed cultivar – Lisek			
Cultivation site (province, site)	Yield dt/ha	Oil mass kg/ha	Oil volume dm^3/ha
Wielkopolskie – Kruszewnia	44.1	1530	1720
Opolskie – Dankowice	25.0	712	792
Dolnośląskie – Ząbkowice Śl.	42.0	1357	1508
Małopolskie – Węgrzce	40.4	1075	1196
Małopolskie – Zagórze	35.2	1250	1387

On the basis of data demonstrated in Table 4, we can say that culture conditions have an enormous influence on the amount of oil obtained from a cultivation area. From rapeseed variety Lisek, cultivated (according to OBROL company information's) with high cultivation technology standards, 1530 kg of oil can be obtained. While, from rapeseed cultivated in Śląsk province, site Dankowice, only 712 kg of oil can be obtained. Clearly, the cultivation technology level was very low, which can also be seen from the obtained harvest, as 25 dt/ha is a very low harvest in comparison to harvests usually obtained for spring varieties. Low cultivation technology level (small dose of fertilizer, only about 30% of the recommended dose) is probably the reason for the comparatively low harvest. However, at the same time, from the mass unit of this variety, the biggest amount of oil – 351 g from 1kg of rape – was obtained.

CONCLUSIONS

1. Applying the method of cold stamping allowed for obtaining from 275 g to 389 g oil from 1kg of rape. This indicates that from the most favorable variety Kana, 41% more oil can be obtained than from the least favorable variety Lirajet. Taking into account oil density, it was found out that 437 ml can be obtained from the best variety Kana, and 306 ml from the worst variety Lirajet.
2. From 1 hectare of cultivation area, the biggest amount of oil – 1592 kg – can be obtained from Californium variety, and the smallest amount – 1158 kg – from Lirajet variety. This indicates that from the cultivation area of Californium rapeseed 37% more oil mass can be obtained than from the same cultivation area of Lirajet. Displaying oil output in volume values, it was found out that the biggest amount – 1760 dm^3 – was obtained from two varieties: Amor and Pomorzanin. The smallest amount – 1288 dm^3 – was obtained from a culture of Lirajet variety. This indicates that, from a cultivation area, we can obtain 37% more oil from the most favourable variety than from the least favourable one.
3. Cultivating Lisek variety in many different places and with different cultivation technology standards, showed that the difference in oil output from 1kg of rape can even

reach 40%. Taking into account rape harvesting, which differed a lot, it was found out that the smallest oil amount was obtained from Lisek cultivation in Dankowice site, Śląsk province – only 712 kg – and the biggest amount – 1530 kg – was obtained from rapeseed cultivation in site Kruszenia in Wielkopolska province. This indicates that the difference is very big and reaches 214%. This clearly shows that weather-soil conditions and cultivation technology standards can have an extremely significant influence on rape harvest and oil output.

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