Oilcake as a fuel alternative to wood pellets

Yuichi Kobayashi[1], Hitoshi Kato[2], Genta Kanai[1]
[1]National Agricultural research Center, Tsukuba 3058666, Japan, kobay@affrc.go.jp

ABSTRACT

Raw sunflower oilcake was obtained from a type of oil mill expeller and was found to contain 6.9-9.5% residual oil and 20.4-21.4 MJ/kg calorific value. Pellet fuels were produced from ground sunflower oil cake using a pelletizer. The capacity of the pelletizer and the characteristics of dried pellets depend on the initial water content of the oil cake. The appropriate values of water contents were about 20 % w.b.

Key words: biomass –oilcake –pellet –production.

INTRODUCTION

Sunflower seeds consist of more than 40% oil; consequently, 60% is classified as oil cake. Although sunflower oil cake can be used as fertilizer, livestock feed, and new materials (Rouilly et al., 2006), it is not easy to use it effectively because of its nutritional properties. As examples of other oil crops, olive oil cake and rape seed oil cake have been used as energy sources (Filiz, 2000; Oktay, 2006; Alkhamis and Kablan, 1999). Results of those studies have demonstrated that oil cake is useful as a potential energy source.

Wood pellets are one way of using biomass as an energy source. They have superior handling characteristics and storability; they are used in various countries. Some burning appliances use wood pellets, but still on a small scale (Sippula et al., 2007).

For this study, we produced a pellet fuel using sunflower oil cakes. It was clear that the capacity of the pelletizer and the characteristics of dried pellets depend on the initial water content of the oil cake. The properties of sunflower oil cake pellets were analyzed following wood pellet standards.

MATERIALS AND METHODS

The variety of oilseed sunflower '63M80' cultivated in the test field of the National Agricultural Research Center was used in the experimental study.

The sunflower seed samples were expressed using a type of oil mill expeller (KEK P0101; Egon Keller GmbH & Co. KG, Germany). Raw sunflower oil cake was obtained as a by-product of the sunflower oil mill. The pressure was adjusted according to the pitch between a press ring and a pressure cone. During the expression, the expulsion rate, surface temperature and the thickness of oilcake was measured. Initially, the oil cake was not uniform in size, thickness, and shape. The sample was ground by rice husk grinder and sprayed with mist to adjust the water content to a value of between 9 and 20% w.b.

The oil cake was pelletized using a ring die type pelletizer equipped with an 11 kW motor. The pelletizer had a 250-mm-diameter and a 40 mm thickness ring die. The obtained pellets were cylindrical with 6 mm diameter. The length was changed optionally; it was set to 30 mm in this test. The ground oilcake was supplied using an auger screw; it was set to 12 rpm for this test.

The product capacity of this pelletizer was calculated from the weight of pellets. The rate of production was calculated from the samples retained on the range of the 4-mm sieve. The pellet temperature was measured using a radiation thermometer. All pellets were stored under ambient conditions for a week to stabilize the water content before testing.

Characteristics of raw oil cake without grinding (ROC) and oil cake pellets (OCP) were measured using approximate standard methods determined in JIS-Z7302, PC WPFS-1, and JHIAN-5651 (JHIA, 2006). After cooling, the ROC was measured for bulk density.

Calorific values were obtained using a standard bomb calorimeter (1013-B; Yoshida Seisakusho Co., Ltd., Japan). Wood pellets were measured as a control pellet.

Cake residual oil was obtained using a fat analyzer (B-815/820; BUCHI, Switzerland).

RESULTS AND DISCUSSION

The results of characteristics of oilcake are presented in Table 1 and the capacities are presented in Table 2. The oil cake characteristics depend on the conditions of compression process. Fastening the expeller tightly, the ROC volume decreased and the thickness decreased. The ROC temperature rose to 82.4°C because of friction heat.

Table 1. Characteristics of oilcake

Expulsion pressure	Thickness (mm)	Surface temperature (°C)	Residual oil (%)
High	4.18	82.4	6.93
Low	8.66	73.0	9.48

Table 2. Capacity of the expeller

Expulsion pressure	Expulsion rate (kg/min)	Gauge index (mm)	Thickness (mm)	Rate of Oil cake (%)
High	0.45	50	4.18	64.5
Low	0.47	55	8.66	67.0

The results of the calorific value are presented in Table 3 along with data of wood pellets. The average calorific value of ROC was 20.99 MJ/kg. When this value is compared to that of white pellets of cedar and pine (c), ROC has a 5% higher calorific value. Although it is difficult to conclude that ROC has a higher calorific value than wood pellets, it shows that sunflower oil cake offers a potential source of energy.

Table 3. Calorific value

		Higher Calorific Value (MJ/kg)
a	ROC	20.99
b	Needle leaf tree	19.30
c	Cedar and Pine (white)	19.91
d	Cedar and Cypress (blend)	19.74
e	Cedar (bark)	19.74

Fig. 1 shows the result of the product. In this test, the initial water content was from 9.0% w.b. to 27.7% w.b. Although the product was from 443.1 g/min to 540.8 g/min at less than 21.0% w.b., it decreased to half at 27.7% w.b. because the flow ability of oil cake decreased with increased water contents.

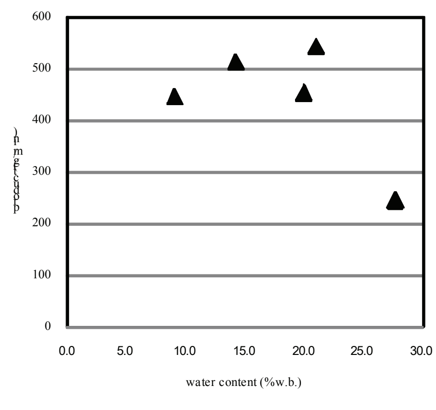

Fig. 1. The relationship between water content and product

Fig. 2 shows that the OCP length of greater than 19.9% w.b. was roughly equal to 30 mm, which is a set length of the pelletizer. The OCP of less than 14.4% w.b was shorter than the set length.

Fig. 3 shows that the shatter indices increase with decreasing initial water content: the indices were 12.5% w.b. at 9.0% w.b. The standard of IWATE requires a shatter index of less than 1%. Therefore, the samples with greater than 19.9%w.b. conformed to the standard.

Fig. 4 presents the relationship between the initial water content and the mechanical strength. The strength increased with increasing initial water content. The strength was found to correlate linearly with initial water content of OCP.

The results showing the product, length, and hardness of pellets showed that the optimum water content was at 19.9–21.0% w.b. in this test.

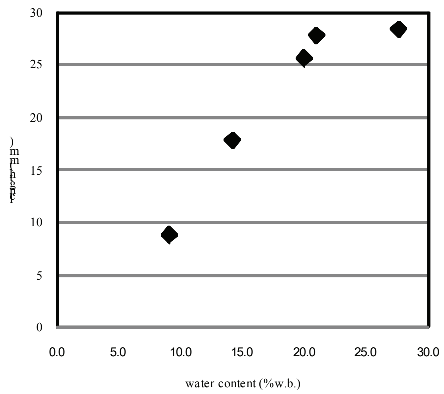

Fig. 2. The relationship between water content and length

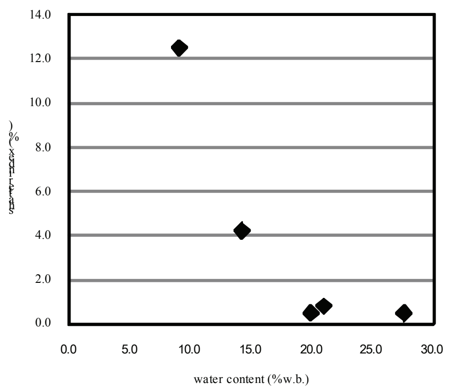

Fig. 3. The relationship between water content and shatter index

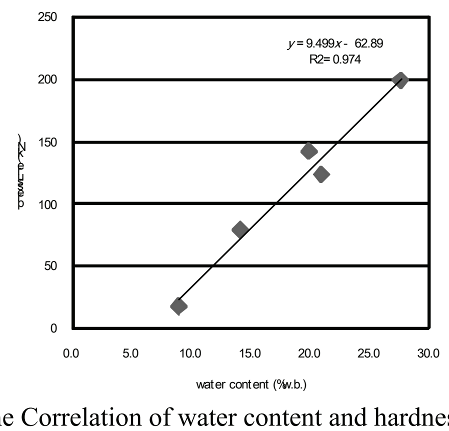

Fig. 4. The Correlation of water content and hardness of pellet

CONCLUSIONS

To use sunflower oilcake as fuel, pellet fuels were produced from sunflower oilcake. The product was stable at least 21%w.b., it decreased to half at 27.7%w.b. because the flow ability of oilcake decreased with increased water contents. The results of the pellet product, length and hardness showed that optimum water content was at 19.9-21.0%w.b. in this test. Oilcake has 20.99MJ/kg calorific values, which are within the standard range of wood pellets.

ACKNOWLEDGEMENTS

This work was supported by KAKENHI (B)-18780195.

REFERENCES

Alkhamis, T.M., and M.M. Kablan. 1999. Olive cake as an energy source and catalyst for oil shale production of energy and its impact on the environment. Energy Convers. Manage. 40:1863-1870.

Filiz, K. 2000. Biobriquetting of rapeseed cake. Energy Sources 22:257-267.

JHIA. Standard of wood biomass pellets, JHIAN-5651 (in Japanese). Japan Heating Appliances Inspection Association, Tokyo, 2004.

Oktay, Z. 2006. Olive cake as a biomass fuel for energy production. Energy Sources, Part A 28:329-339.

Pellet Club. Self standard of wood pellet by pellet club, PC WPFS-1 (in Japanese). Pellet Club, Kyoto, 2005.

Rouilly, A., O. Orliac, F. Silvestre, and L. Rigal. 2006. New natural injection-moldable composite material from sunflower oil cake, Biores. Technol. 97:553-561.

Sippula, O., K. Hytonen, J. Tissari, T. Raunemaa, and J. Jokiniemi. 2007. Effect of wood fuel on the emissions from a top-feed pellet stove. Energy and Fuels 21:1151-1160.