BIO Web of Conferences **81**, 00022 (2023) https://doi.org/10.1051/bioconf/20238100022
ICESAI 2023

Quality evaluation of waste cooking oil from restaurants in Malang as the potential for ruminants feed supplement

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Abstract. Derived from hypothesis of having more fat content in feed could inhibit microbial activity and will increase the energy for the ruminants, this research conducted to determine the contrasting quality of fresh and waste cooking oil. Analysis focused on organoleptic and iodometry to initiate a supplementation product. Material used were fresh and waste cooking oil from four chicken restaurant in Malang: A Restaurant (T_1), B Restaurant (T_2), C Restaurant (T_3), and D Restaurant (T_4). Data collected thrice a day regularly and apprised that different cooking oil brands used. Brand A used in A (T_1) & B Restaurant (T_2), brand B used in C Restaurant (T_3), and brand C used in D Restaurant (T_4). Analysis executed at Animal Nutrition and Feed Laboratory, Animal Science Faculty of Universitas Brawijaya with 15 panellists. Using randomized nested block design; four restaurants, two types of, and three replications (4x2x3); It can be perceived that the cooking oil waste on each restaurants has significant effects on the smell and texture. The panellists concurred that the best cooking oil waste as the potential for ruminants feed supplement, is the C Restaurant (T_3) with the greenish yellow colour, thick texture, slightly slack odor, and tasted a bit bitter. However, all the restaurants' fresh cooking oil, by iodine content analysis, higher than the standard of Indonesian National Standards. T4 hit the highest with 61.87 g Iod/100g compared to T1, T2, and T3 with 52.68, 48.44, and 53.90 g Iod/100g respectively. It can be concluded that the best cooking oil waste for the potential feed supplement is the C Restaurant (T3) with 53.90 ± 1.09 g Iod/100g iodine level.

1 Introduction

About 70% of the production cost in livestock farming is the cost of procuring feed. In addition, feed costs also play a role as a determining factor in the viability of the production system so that it is necessary to reduce costs on feed but on condition that nutrient supply is met according to the standard. Feed with good nutrition will produce good production and reproduction when given to livestock, one of the important nutrients is energy. Ruminants can digest forage as a source of fiber in the rumen into volatile fatty acids which can then become a source of energy. In addition, ruminants still need energy that is more quickly or easily degraded in the rumen such as starch or fat [1].

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Ruminant livestock is one type of livestock that is able to make a major contribution to human welfare by providing the most potential animal protein through meat and milk if the nutrients needed are not met, it can affect the product yield of the livestock. Ruminants use carbohydrates as their main source of energy, while reserve energy comes from fat [2]. Low production and reproductive performance of livestock is caused by insufficient supply of essential nutrients such as amino acids, fatty acids, minerals, and energy so that the addition of oil in feed is necessary. Adequacy of energy and essential fatty acids can be met by the addition of oil. The purpose of fulfilling essential nutrients is to increase ration energy and modify the composition of fatty acids in ruminant body tissues [3].

The addition of oil to the ration has several benefits including increasing ration energy, increasing the efficiency of energy use through inhibition of methanogenesis as a defaunation agent [4]. Oil added to the ration of ruminants can cause a decrease in microbial activity in the rumen. As it is known that the advantage of ruminants lies in their ability to utilize fiber, therefore it is necessary to effectively use feed with fat protection [5].

Meeting the need for oil in the ration can be met by utilizing waste cooking oil. Malang is one of the cities that is well known as a cuisine centre with many restaurants and eateries that produce a large quantities of waste cooking oil. The waste cooking oil is the oil residues that are left and discarded after deep frying and broiling food. It is usually disposed off and may cause environmental pollution. It has been shown that waste cooking oil can be used in feed as source of energy. In addition to reducing environmental pollution, the use of cooking oil waste can also reduce feed costs. However, the use of waste cooking oil in feed needs further research on its feeding value and quality. The objective of this study was to conduct a survey on the production of waste cooking oil from several restaurants in Malang district, and their colour, odor, texture, and flavour. The Iodometric tests on the oils were also carried out.

2 Materials and Methods

2.1 Experimental design

Oil sampling was carried out at four fried chicken restaurants. Organoleptic analysis was conducted at the Animal Nutrition and Feed Laboratory, Faculty of Animal Science, Universitas Brawijaya. Iodometric analysis was conducted at the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Brawijaya.

2.2 Sampling of waste cooking oil

The waste cooking oil were obtained from four different restaurants, namely A, B, C, and D Restaurant. Iodometric Test were conducted on the oil samples following the method of [6].

2.3 Research method

This research was conducted using a survey method in four food restaurants, namely A, B, C, and D Restaurant which were restaurants with many customers. Data collected in this study include primary data obtained from direct interviews with respondents using questionnaires and direct observations, while secondary data are obtained from data on the amount and type and date of use of cooking oil by each restaurant. Organoleptic test data was obtained from the assessment of panellists with the criteria of panellists aged 18-25 years, male or female and have experience in cooking.

Two types of samples were taken, namely samples from unused oil (bottled) and waste oil samples (waste oil that was discarded). This used oil sample was taken from each restaurant as much as 500 mL. Sampling was done 3 times on different days as a replicate. Each sample taken is placed in a glass bottle labelled with the date of collection, the name of the restaurant, the type of oil (new or used), while waiting for the sample analysis schedule that is not studied is placed in the freezer so as not to stale. The collected samples were then analysed for physical quality and iodometric test.

2.4 Research variables

The tested variables include organoleptic and iodometric tests of waste oil from each restaurant and also compared with new oil unused in each restaurant.

2.5 Data analysis

The research data were analysed using Analysis of Variance (ANOVA) in Randomized Group Design (RAK) because the conditions of each restaurant were not homogeneous. The analysis aims to determine the effect of the number of puppies on the research variables. If the test concluded that the treatment or group had a real effect, it was continued with the Real Differential Test.

3 Results and Discussion

Sensory Characteristics of Waste Oil in Restaurants towards the Potential of Waste Oil as an Animal Feed Supplement. The following are the results of a survey of several restaurants in Malang.

Table 1. Survey results on the use of cooking oil in fried chicken restaurants in Malang City

Restauran t	Replication	Bran d	Fresh cooking oil (liter/day)	Fried portion (pcs)	Usage ratio (ml/pcs)	Waste produced (liter/day)	Waste treatment
T_1 (A)	R_1	A	16.00	1800	7.2	3.00	Distributed to hoarder
	R_2		15.00	1700	7.1	3.00	
	R_3		18.00	2100	6.9	3.50	
T_2 (B)	R_1	A	22.00	2400	7.1	5.00	Disposed
	R_2		20.00	2100	7.6	4.00	
	R_3		19.00	2050	7.3	4.00	
T_3 (C)	R_1	B	20.00	2200	7.5	3.50	Disposed
	R_2		19.00	2000	8.0	3.00	
	R_3		23.00	2500	7.6	4.00	
T_4 (D)	R_1	B	15.00	1800	6.7	3.00	Disposed
	R_2		13.00	1600	7.2	1.50	
	R_3		14.00	1700	7.0	2.00	

According to the survey results, several restaurants produce waste cooking oil with an average of 15-20 liters of waste oil per day. Most of the restaurants disposed off the used oil onto the drains and sewage system.

3.1 Organoleptic Test

The number of panellists was 15 people with an age range of 18-25 years obtained from the provision of training to determine certain sensory properties before testing. The following are the results of the panellists' assessment of the new oil with waste cooking oil.

Table 2. Results of panellists' assessment of new cooking oil (M_1) with waste cooking oil (M_2)

Treatments		Colour Quality (1-5 scale)	Texture Quality (1-5 scale)	Odor Quality (1-5 scale)	Flavor Quality (1-5 scale)	Description (Color, Texture, Odor, Flavor)
M_1	T_1	4.800	5.000	5.000	5.000	Transparent yellow, thick, fresh
	T_2	4.800	5.000	5.000	5.000	Transparent yellow, thick, fresh
	T_3	4.800	5.000	5.000	5.000	Transparent yellow, thick, fresh
	T_4	4.800	5.000	5.000	5.000	Transparent yellow, thick, fresh
Average		5.000	4.800	5.000	5.000	Transparent yellow, thick, fresh
M_2	T_1	3.044	2.378	2.778	3.044	Greenish yellow, thick, rancid
	T_2	2.867	3.044	2.867	2.822	Brownish yellow, very thick, bit rancid
	T_3	3.067	3.156	3.044	3.178	Greenish yellow, thick, bit rancid
	T_4	2.711	3.156	2.778	2.756	Brownish yellow, very thick, bit rancid
Average		2.950	2.922	2.934	2.867	Brownish yellow, very thick, rancid

3.1.1 Colour

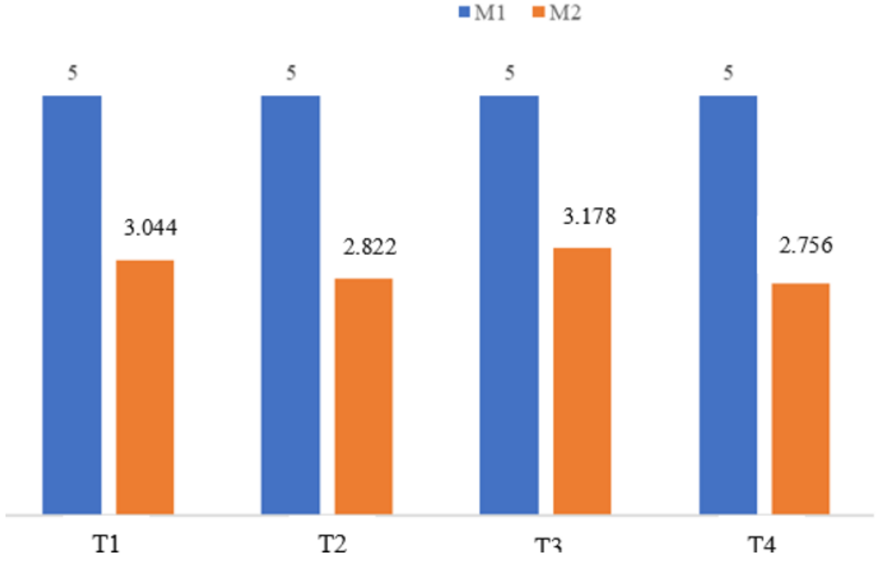

Fig. 1. Organoleptic of colour

The colour organoleptic test was conducted based on the level of preference of 15 panellists. Based on the graph above, the colour value of the new cooking oil from T1 to T4 has the same average value of 5, which means that all new oils from T1 to T4 have a clear yellow colour. Meanwhile, in the graph, the panellists considered that the waste cooking oil experienced a change in colour, this can be seen from the results of the panellists' average value of 2.950, which means that the colour changed to a brownish yellow colour. The waste cooking oil that has the darkest colour among the others is waste oil C from restaurant D and the waste oil that has a fairly good colour is oil B from restaurant C.

Changes in used cooking oil are caused by oxidative damage [7]. Oxidation reactions occur between oxygen and double bonds of triglycerides / oil [8]. The presence of antioxidants (tocopherols) in oil is useful for diverting the oxidation process from oil to antioxidants so that oil bonds remain intact. In addition, the presence of molecular bonds of carbohydrates and proteins, or referred to as the Maillard Reaction, which is the reaction between the carbonyl group and the amine group of the protein, is also the cause of the brown colour of used cooking oil. The dark colour of the oil can also occur during the processing, storage and use of the oil. Heating is too high and repetitive, causing polymerization reactions and Maillard reactions that cause the oil to thicken and darken [8]. The greater the colour density of a solution, the more turbid the solution, and the worse the quality of the solution. It is necessary to purify the colour of waste cooking oil in order to improve the potential quality of waste oil as animal feed [9].

3.1.2 Texture

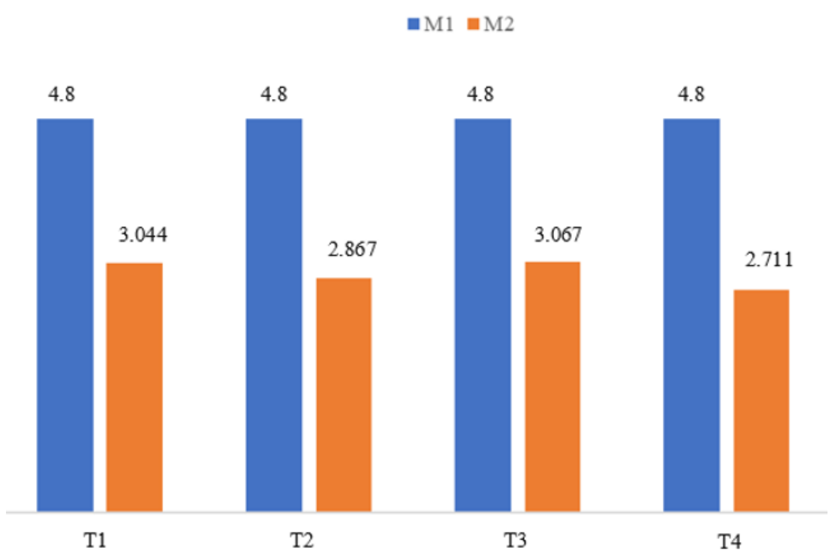

Fig. 2. Organoleptic of texture

The organoleptic texture test was conducted based on the level of preference of 15 panellists. Based on the graph above, the texture value of the new cooking oil from T1 to T4 has the same average value of 4.8, which meant that all new oils from T1 to T4 have a slightly thick texture. As for waste cooking oil, based on the graph above, the texture value with the lowest average was found in waste cooking oil D Restaurant (T4) which is 2.8 which means thick tends to be very thick while the highest average value is found in waste cooking oil C Restaurant (T3) which is 3.067 which means thick. T1 shows that waste oil brand A in A Restaurant is on average classified as a waste oil assessment with a thick texture with an average value of 3.044. Meanwhile, Waste oil A in B Restaurant (T2) still gets a value close to 3 so it is still very thick texture. Waste oil B from C Restaurant T3) is classified as a thick texture assessment because it has a value above 3. While waste oil C from D Restaurant (T4) has the lowest value with a value of 2.8 so it is still a very thick texture.

Oil becomes thicker, foamy, brown in colour, and leaves a slightly bad odor due to various kinds of damage due to oxidation, hydrolysis, polymerization, and metal reactions [10] Repeated heating of oil at high temperatures and a long enough time will produce polymer compounds that are solid in oil. Oil that has been damaged not only causes damage to nutritional value but also damages the texture of the flavour of the fried food [11]. The texture of cooking oil that has been used many times will have a thicker texture than fresh oil due to the formation of acidic polymers, dimers and glycerides during heating when used [12]. There is no difference in the odor of each treatment because it has an average value that is not much different (the same), which has a value close to 3, which means that the texture of the waste oil is rather thick.

3.1.3 Odor

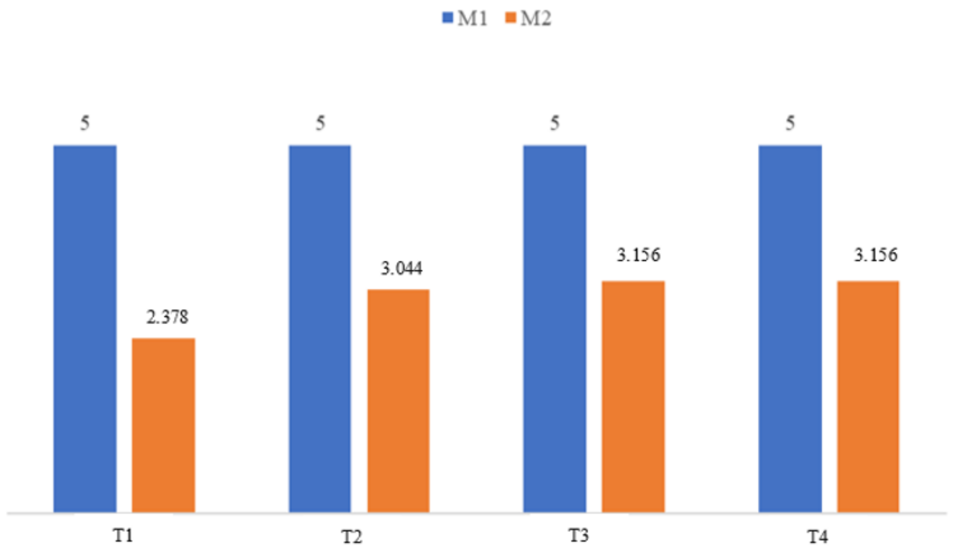

Fig. 3. Organoleptic of odor

The organoleptic odor test was conducted based on the level of preference of 15 panellists. Based on the graph above, the odor value of new cooking oil from T1 to T4 has the same average value of 5, which means that all new oils from T1 to T4 have the typical smell of new oil. While the waste cooking oil, based on the graph above has an average value of 3 so that from the assessment of the waste cooking oil panellists have a slightly bad odor. The restaurant that has the lowest score is restaurant A which has a score of 2.378 which means it has a worst odor than the other three restaurants.

This condition is possible because during the food frying process, the oil undergoes decomposition Fat hydrolysis reaction occurs when fat is hydrolysed into free fatty acids and glycerol. The cause of rancidity is due to the formation of free fatty acids. Rancidity in oil is felt when the oil contains free fatty acids, especially at low temperatures. Fat oxidation reactions occur in fats that contain unsaturated fatty acids in the carbon chain, have single or multiple double bonds. Changes starting from free radicals if oxygen is available will form peroxides which are also radical in nature, then form hydroperoxide compounds and are easily degraded into short-chain compounds from the aldehyde, ketone and alcohol groups which have an impact on the rancidity of the oil [3]. There is no difference in the odor of each treatment because it has an average value that is not much different, which is touching the value of 3, which means it is not slightly rancid. The deterioration of fat is the development of a rancid odor and taste, which is called the rancidity process. It is caused by factors that can accelerate the reaction, such as heat and light. Oxidation can also occur when there is contact between a certain amount of oxygen and oil or fat. The occurrence of this oxidation results in a rancid odor in oil or fat [13]. So, the oil is not good if consumed. Oil or fat refining is needed to eliminate bad taste and odor, unattractive color and extend the shelf life before consumption [14].

3.1.4 Flavour

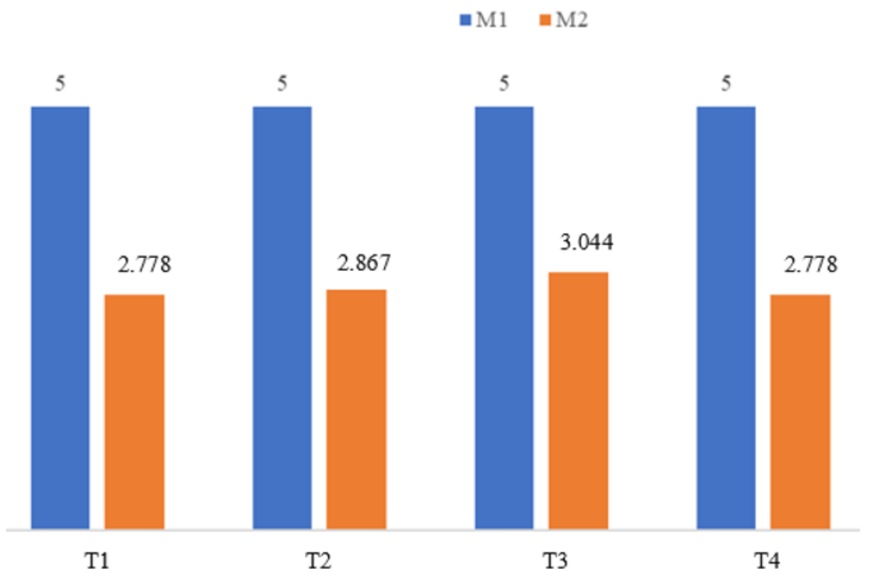

Fig. 4. Organoleptic of flavour

The organoleptic taste test was conducted based on the level of preference of 15 panellists. Based on the graph above, the taste value of the new cooking oil from T1 to T4 has the same average value of 5, which means that all new oils from T1 to T4 have a normal bland taste. While the average waste cooking oil has a value of about 2.867 which is classified as having a bitter taste. However, in T4, the C restaurant has the best value among other restaurants, which is 3.004, which is classified as having a slightly bitter taste.

3.2 Iodine Content

In determining the quality of oil there is a standard that becomes a reference. For domestic use, the standard used is SNI (Indonesian National Standard), but for cooking oil to be exported, the SPB (Special Prime Bleach) standard is used.

The average iodine content of new cooking oil is 55.183 g Iod/100g. According to SNI - Coconut Oil Technology - SNI - 3741 - 2013 and Special Prime Bleach (SPB), all new cooking oils from T1 to T4 have exceeded the minimum limit of iodine content in new cooking oil.

Table 3. Iodometric Test Results according to SNI-Coconut Oil Technology-SNI-3741-2013

Treatments		Iodin Content (g Iod/100g)	SNI - Coconut Oil Technology - SNI - 3741 - 2013	Special Prime Bleach (SPB)
M_1 (new cooking oil)	T_1	55.320	45 – 46 (g Iod/100g)	53 ± 1,5 (g Iod/100g)
	T_2	55.320		
	T_3	53.050		
	T_4	57.040		
Average		55.183		
M_2 (waste cooking oil)	T_1	52.680 ± 3.532^{ab}		
	T_2	48.443 ± 1.150^{a}		
	T_3	53.903 ± 1.098^{b}		
	T_4	61.870 ± 2.272^{c}		
Average		54.224 ±2.013		

A cooking oil used at A Restaurant (T1) experienced a decrease in iodine levels from new oil that became waste cooking oil with a decrease of 2.64 g Iod/100g. A cooking oil used at B Restaurant (T2) experienced a decrease in iodine levels from new oil which became waste cooking oil with a decrease of 6.877 g Iod/100g. Meanwhile, B cooking oil used in C Restaurant (T3) experienced an increase in iodine content from new oil which became waste cooking oil with an increase of 0.853 g Iod/100g. As happened in T3, C cooking oil used in D Restaurant (T4) experienced an increase of 4.83 g Iod/100g. Based on the results of this study, the average waste cooking oil had low iodine values. The decrease in iodine content is due to the heating of the oil which causes the breaking of unsaturated bonds to become saturated. this is also supported by the opinion of [15], At an increase in temperature the double bond is reduced because the double bond is split into single bonds during heating which results in the iodine number going down [16]. However, the iodine number produced is still above the SNI standard so it is still suitable for use. Meanwhile, the increasing iodine value in used cooking oil can be considered as the best quality oil and suitable for consumption.

4 Conclusion

Based on the results of this study, it can be concluded that waste cooking oil obtained from four restaurants showed changes in colour, texture, odor and taste. However, it had a high iodine content which indicate that the waste cooking oils from the restaurants selected were still suitable for consumption by livestock.

References

1. E. Wina, and I.W.R. Susana, *WARTAZOA. Indonesian Bulletin of Animal and Veterinary Sciences*, **23**, 4 (2013)
2. S. Sudibya, K.R. Akbar, W.P. Sabar and J. Riyanto, Sains Peternakan, **15**, 1 (2017)
3. A. Prarudiyanto, E. Basuki, A. Alamsyah, D. Handito, Jurnal Ilmiah Rekayasa Pertanian dan Biosistem. **3**, 41-48 (2015)
4. U.H. Tanuwiria, D.C. Budinuryanto, S. Darodjah and W.S. Putranto, *Jurnal Ilmu Ternak*, **10,** 32-38 (2011)
5. A. Abqoriyah, S.D. Widyawati, and L. Lutojo. Zoo Indonesia. **22**, 2 (2013)
6. Yeniza, and P.A. Anjar. Amina. **1**, 2 (2019)

7. I.O. Angelia, JTech, **4**, 32-36 (2016)
8. A.S. Suroso, Jurnal Kefarmasian Indonesia. **3**, 2, 77-88 (2013)
9. F. A. Viantini, Konversi. **4**, 2, 53-62 (2015)
10. R. Hartono and E. Suhendi, JIP. **9**, 1 (2020)
11. S. Chodijah and A.P. Harmansyah, Kinetika, **1**, 1 (2011)
12. M. Milawarni, and S. Saifuddin, Jurnal Teknologi Kimia Unimal, **6,** 2, 52-62 (2018)
13. P.V. Patty, Biopendix. **1**, 2, 146-152 (2015)
14. R.E.P. Gusti and Zulnely. Jurnal Penelitian Hasil Hutan **33**, 1, 61-68 (2015)
15. F. Estrada, R. Gusmao, N. Indraswati, Widya Teknik. **6,** 2, 121-130 (2017)
16. F. A. Viantini, 2015. Konversi. **4**, 2, 53-62 (2015)