Research Journal of Agronomy 2 (4): 112-118, 2008
ISSN: 1815-9354

Quality Control of the Stems of Palm Trees at Palmci-Irobo Oil Mill

[1]Bohoua Louis Guichard, [2]Kouame Patrice and [3]Djè Kouakou Casimir
[1]Department of Food Science and Technology,
University of Abobo-Adjamé Côte d'Ivoire, 02 BP 801 Abidjan 02 Côte d'Ivoire
[2]Maître de Conférence, Doyen de l'Unité de,
Formation et de Recherche des Sciences et Technologies des Aliments,
Université d'Abobo-Adjamé Côte d'Ivoire, 02 BP 801 Abidjan 02 Côte d'Ivoire
[3]Department of Food Engennering,
Centre Universitaire Professionnalisé, 06 BP 1352 Cedex 1 Abidjan 06

Abstract: The control and analysis of the quality of the palm tree stem performed to increase the oil production rate were carried out using visual analysis at three levels. The control in the field, at the entry of the factory and during unloading. The physical analysis consisted of randomly selection of a collection vehicle, after its identification, sorting and classifying its content according to the following configuration: Ripped stems, green stems and stems with long peduncles. A chemical analysis consisting of taking a representative sample of the loading configuration was carried out in order to determine the potential of oil extraction. This control system adopted enabled to significantly reduce green stems from 15-1.3%, rotted stems from 14.2-1.3%, the length of the peduncles from 33.8-0.8% and impurities from 6.5-1.7%. We also noticed during the current year an increase in the ripped stems from 81.6-97.4% having for consequence an increase in the production rate of oil at the factory from 20.1-23.7% (being a profit of 3.6%).

Key words: Stem, palm tree, quality control

INTRODUCTION

Palm tree, a monoïc and heliophilous plant called *Elaeis guineensis* is originating from the gulf of Guinea (Amorós *et al*., 2003; Serrano *et al*., 2001). It is a significant source of fat content. Previously intended for family consumption in Africa. Today, it is used in the food industry and in cosmetics (Kalanithi and Wong, 2007; Tan *et al*., 2007). Thus, in order to satisfy different needs, vast plantations were created not only in Africa but also in other countries like Antilles, South America, Malaysia and Indo-China (Yusof, 2007). This accelerated expansion is due to its high oil potential (Cheyns *et al*., 2004). Palm tree is thus, cultivated for its fruits which offer the best oil output per hectare. As matter of fact palm tree produces 5-7 times more oil per hectare than groundnut and soya (Anonymous, 1998). The quantity of the palm oil produced depends on the quality of the treated stems (Braipson and Gibson, 2007) and is closely related to the configuration of the stem delivered at the oil mill. From this analysis, it is important to increase the output of the oil production in the factory. Thus, an incentive policy to the quality of the stem and the implementation of a system of analysis and the control of the stems quality were initiated. The qualitative analysis of the stems should make possible the evaluation of the work in the plantation and to intervene at a given period to correct possible drifts. This study has for main objective to guide farmers to deliver of good quality stems to the oil mill and especially to increase the yield of palm oil extraction in the factory.

MATERIALS AND METHODS

Stems of palm tree (*Elaeis guineensis*) are used. The stem measures 10-50 cm length and has an average weight between 10-25 kg.

Broad sensibilization: A broad sensibilization over a period of 3 weeks was carried out next to all actors intervening in the field of palm tree. A quality stem local committee (CLQR) was created under the authority of the director of the Agro-business unit (DUAI), to better explain the policy of quality control and the new

Corresponding Author: Dr. Bohoua Louis Guichard, Department of Food Science and Technology,
University of Abobo-Adjamé Côte, d'Ivoire 02 BP 801 Abidjan 02 Côte d'Ivoire

disposition to be adopted for a delivery of stems of good quality. The sensibilization consisted of organizing information sessions of and training on the quality requirements and actions to be taken to achieve the goal.

Current actions: The local stem quality committee meets once a week to make the point on the work carried out and to check results of the physical analysis of the week in order to suggest corrective actions. Signs of sensibilization at the entry of the factory and at the calling place were made to reinforce sensibilization. The representatives of the village, farmers, harvesters and scorers of PI (Industrial Plantation) as well as drivers and collectors are regularly informed, sensibilized and called to put order each time that a deficiency is observed. The manager checks and controls if the harvest is done in village farms on the basis of two harvests per month and in PI at a frequency of 10-12 days in order to avoid the harvest of defective stems.

Visual analysis

Controls in the field: The day of harvest, after the positioning of harvesters according to the row of palm tree, the stem quality standards and the sanctions inflicted in the event of non respect, are reminded to them before at the beginning of research. Let us point out that the stem should be collected at a good ripeness (>90% of the collected stems must be ripped), the number of green stems should not have to exceed 5%; the rotted stems must be eliminated and the long peduncles must be at the neck of the stem. In the presence, of the group manager, the collected stems are transported and put together on surfaces intended for this purpose. Indeed, the surfaces of collection are removed from impurities (stones, grass, twigs, pieces of wood). Free fruits are also collected surface collection. The collected stems with long peduncles sare removed and the defective stems are thrown away before the count is done by the scorer. Then, the manager checks if the surface of collection is deprived of impurities and all the free fruits are carefully collected. At last, heavy plant drivers in charge of the collection in PI are instructed to rigorously respect the standards of the quality of the stems to be loaded. At the collection areas, stems being rotted are shaken in order to get only normal fruits. The impurities (sand, stones, twigs) and green stems are also eliminated during the stem collection. Stems with long peduncles having escaped to the scorer are cut before the loading.

Controls at the entry of the factory: The control at the entry of the factory is based on the observable parameters (green stems, rotted stems, stems with long peduncle). At the entry of the factory, trucks of collection are checked in order to detect defective stems. A given truck of collection with at least 5 defective stems has its content systematically poured and sorted out before being weighed on the weighbridge.

Control upon unloading: Stems are brought to the factory in trucks of collection. The loaded trucks are weighed at the entry of the factory and are emptied. The difference in the weight gives the weight of stems delivered. Upon unloading, control is more vigorous. Indeed all the green, rotted stems and stems with long peduncle are systematically withdrawn from the batch. Long peduncles are cut at the neck of the stem. These cut peduncles as well as green and rotted stems withdrawn are put back in the truck of collection before being weighed at the exit gate. Thus, the weight of defective stem is not taken into account.

Physical analysis

Sampling: Everyday a collection truck of is randomly selected. After its identification (origin, last name and first name of the farmer), the truck is weighed on a weighbridge. The entire loading is poured on the tiled floor reserved to check the quality of the stem. The sorting is done according to the following configuration.

A ripped stem: A stem is regarded as being ripped when the color of the fruits has turned to red and shows at least 5 fruits naturally separated.

A green stem: A stem is known as green when the color of the fruits has not turned to red and none of its normal fruit having been naturally separated on the day of harvest.

A rotted stem: A stem is regarded as rotted if the peduncle becomes spongy, fibrous switching from the brown to the black color.

A stem with a long peduncle: A stem with a peduncle exceeding 2 cm.

Free fruits with impurities: Impurities are made up of stones, sand, grass and pieces of free stems.

Configuration of stems: From the configuration, it is determined the percentage of ripe stems, green stems, rotted stems, stems with a long peduncle.

Rate of free fruits on a complete loading: Free fruits of a loading with impurities are put in a cage and are then weighed after weighing of the empty cage. The difference in these 2 masses gives the mass of free fruits and that of the impurities.

The free fruit rate (FF%) is calculated in the following way:

$$FF\ (\%) = (PFD/Pt)\times 100$$

Where:

PFD = Mass of free fruits + impurities.
Pt = Mass of the loading.

Rate of impurities on the complete loading: An average sample of the separated fruits (5 kg) upon delivery is weighed and sorted in 2 components (free and clean fruits; impurities).

After having weighed each component, the mass of the impurities is determined. Thus, the rate of impurities (imp%) on a given loading is calculated according to the following formula:

$$Imp\ (\%) = (P'/Pt)\times 100$$

Where:

P' = Mass of impurities.
Pt = Mass of the loading.

Chemical analysis

Sampling: The sampling consists of taking a number of representative stems from the configuration of the stems of the loading and 500 g of free fruits. About 6 or 8 stems are selected, while keeping the configuration of the loading, when the mass of the loading is, respectively lower than or equal to 5000 kg and higher than 5000 kg.

Treatment of stems

Rate of fruits on stems: The selected stems are weighed using a Romaine scales of a capacity of 200 kg, chopped and fruits are removed. Fruits are also weighed and put separately in containers. After successive passages of the three categories of fruits in the distributor, an average sample of 500 g was taken according to the configuration of the stems. As matter of fact, the percentage of each category of stems (green, ripped, rotted) allows to calculate the rate of fruits on stems (F/R%):

$$F/R\ (\%) = (PF/Pt)\times 100$$

Where:

PF = Total mass of the fruits.
Pt = Mass of the loading.

Rate of pulp on fruits: Different types of fruits were received at the laboratory and the pulps were removed. The nuts of each sample were weighed. The percentage of pulp of free fruits (P/FF%) and of pulp of the fruits on stems (P/FR%) were given as follows:

$$P/FF\ (\%) = (500\text{-pnd}/500)\times 100$$

Where:

P/FR% = (500-pnr/500)×100.
Pnd = Weight of nuts of free fruits.
Pnr = Weight of nuts of the fruits on stems.

The final percentage of pulp on fruits (P/F%) is given by the average of these 2 percentages above.

$$P/FR\ (\%) = [(P/FF\%) + P/FR\%)]/2$$

Oil extraction: Each category of pulp (green, ripped and rotted) was cut out in small pieces and then mixed to have a homogeneous sample. An average sample of 40 g of pulp (P_0) was transferred according to the configuration of each type of fruit into a clean, dry porcelain crucible. The sample was then placed in a drying oven, large model at 180°C during 2 h (2H). At the end of this operation, the crucible was withdrawn, cooled in a desiccator and weighed to determine the mass of the dried pulp. The dry pulp is then grinded and oil was extracted using hexane by the method of SOXLHET.

The rate of oil on pulp (H/P%) is given by the following expression:

$$H/P\ (\%) = [(P_1\times pH)/(P_0\times P_2)]\times 100$$

Where:

P_0 = Mass of fresh pulp (40g)
P_1 = Mass of the dried pulp.
P_2 = Mass of dried pulp left from the extraction.
pH = Mass of extracted oil.

Thus, the rate of oil extraction (TEH) is given by the formula hereafter:

$$THE = [(F/R\%)/100]\times[(P/F\%)/100]\times(H/P\%)$$

Acidity of oil: The total content of natural acid of a product is determined in a liquid product. About 5 g of oil and 50 mL of ethylene alcohol are taken. Two to three drops of alkaline blue are added to the mixture and the unit is homogenized. A drop of soda is then added there to neutralize free acids. The unit is carried to boiling in order to solubilize oil in alcohol. The mixture is then placed in a burette and is proportioned with soda (0.39 N) up to the turning point.

The rate of acidity of oil (AH%) is determined by the following expression:

$$AH\ (\%) = (V\times N\times 2.56/P)$$

Where:

AH = Acidity of oil.
V = Volume of soda.
N = Normality.
P = Mass of oil.

Dissuasive actions: Precautions were taken in order to encourage actors involved in the process to follow the policy regarding the quality of the stems.

In plantation, any stem collected green results in a reduction of five ripped stems from the total number of the collected ripped stems; harvesters are paid according to the number of collected stems. Furthermore, any batch of stems with rotted stems or gathered on a surface not adapted for the intended purpose is considered null for the harvester.

At the factory, a first refusal of a loading for defect of stems, or presence of impurities leads to a verbal warning of the driver or the tractor operator. A second refusal for the same fault within 1 week is followed of a written warning. In the event of repetition of a non compliance in a row (3-6 times), the driver is given a 3 days suspension in 1 month, this can run up to the suspension of the contract. If at least 2 drivers in a given area are penalized, the supervisor receives at first a letter of recall and is given a period of suspension which could go is dismissal if the problem is repeated.

RESULTS

The number of green and rotted stems refused per week during unloading is given in Table 1.

The analysis of Table 1 shows that the delivery of poor quality stems in general came from the Villagers Plantation (PV).

The configuration of the loading is determined over 10 days starting from the criteria described in the methodology.

The variation of the rate of ripped stems as function of time is plotted in Fig. 1.

Table I: Defective stems rejected at the oil factory per week

	Rotted		Green	
Stems/week	PV	PI	PV	PI
1	353	156	213	155
2	318	97	40	20
3	120	21	35	10
4	110	90	5	5
5	90	84	48	16
6	58	33	32	6
7	13	2	5	0
8	11	2	6	0
9	111	63	5	0
10	110	36	6	1
11	54	31	1	0
12	52	25	4	4
13	45	23	5	1
14	109	62	13	2
15	67	16	10	3
16	52	14	4	1
17	13	4	6	4
Total	1686	829	438	228

PV: Village Plantation; PI: Industrial Plantation

Figure 1 shows that the initial rate of the ripped stems (81.6%) has quickly increased and reached the standard at the 26th decade (that is to say 90.8%). This rate remained higher than 90% (the standard) with an optimum (97.4%) obtained at the last decade (decade 35).

The trend of defective stems (green and rotted) as function of time is represented in Fig. 2.

The curves of green stems and rotted stems are basically identical with an initial high rate being respectively of 15 and 14.2% for green stems and rotted stems. These curves can be divided into 2 parts: the first part is characterized by a rate above the standard and a rapid decrease to reach the standard (lower than 5%). However, the second part is serrated with data being below the standard (5%). As a matter of fact the rate of green stems fell from 15-4.1% after one decade and the rate of rotted stems from 14.2-3.5% after 4 decades. These rates remained below 5% until the last decade with a minimal value being respectively of 0 and 1.3% for the green and rotted stems. The change in the length of the stems peduncles collected in time is given by Fig. 3.

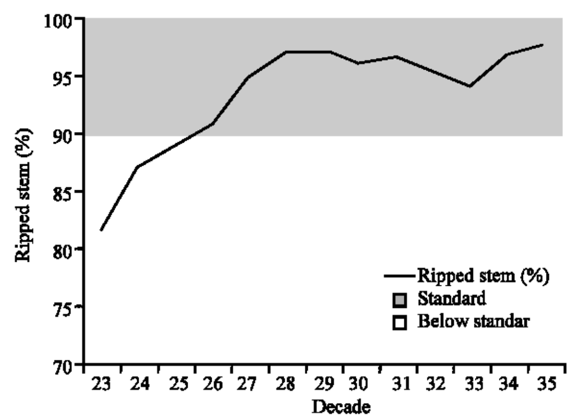

Fig. 1: Changes in the rate of ripped stems as function of time

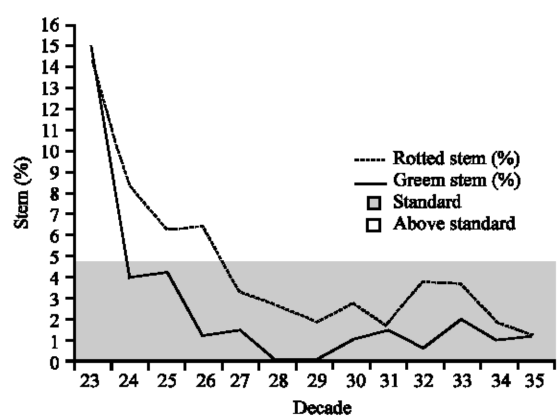

Fig. 2: Changes in the rate ofrotted and green stems as function of time

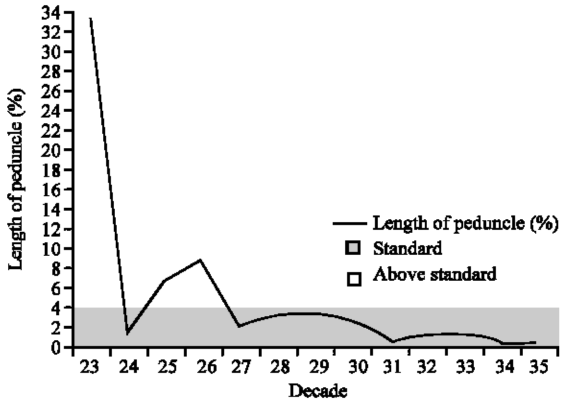

Fig. 3: Changes in the rate of the length of the harvested stems as function of time

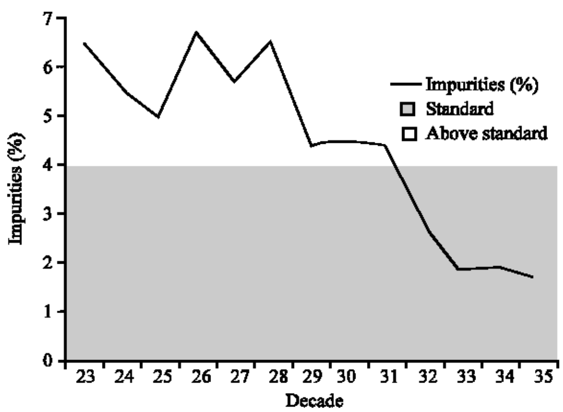

Fig. 4: Changes in the rate of impunrities as function of time

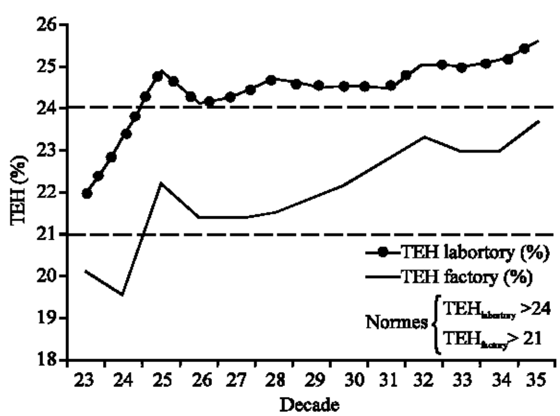

Fig. 5: Changes in the rate oil extraction (THE) in the laboratory and in the factory

Figure 3 also presents two parts. The first one is marked by a drastic decrease of the rate length of the stems going from 33.8% to reach 2.9% after 04 decades. The second part is characterized by a rate remaining lower than the standard (4%) from the 27th decade to the last decade with a minimal value of 0.6% in the 31th decade.

The change in the rate of impurities with time is represented by Fig. 4.

The trend is serrated during the first 9 decades with, respectively maximum and minimal values 6.7 and of 4.4%. This rate of impurities remaining above standard falls to reach a value 2.9% at the 10th decade thus being within the standard (lower than 4%). It continued to decrease to reach the value 1.7% in the last decade.

The different variations of the oil extraction potential (TEH) from the factory and from the laboratory are represented by Fig. 5.

Data analysis reveals that the rates of oil extraction in the laboratory and in the factory are similar. However, in the 24th decade, the rate of oil gradually extraction in the factory fell from 20.1-19.6%, while the rate in the laboratory was increasing. Over the 24th decade the TEH of the laboratory remained higher than that of the factory. The initial output of the oil extraction of the factory (20.1%) after a marked decrease of 0.5%, significantly increased in the 25th decade to reach a value of 22.2%. This value much higher than the standard (21%) was reduced by 0.8% in the following decade then increased to reach an optimum of (23.7%) in the last decade. In addition, the rate of acidity was lower than 4.5% over all the decades.

DISCUSSION

Defective stems (rotted and green) coming from PV and refused at the factory represent the double of those coming from PI. This is due to the fact that Irobo is an area of strong concentration of certain competing companies such as PALMCI, PHCI and ADAM AFRICA. This strong competition leads the village farmers to collect stems in less than 10 days between two harvest times, increasing thus, the probability of collecting green stems. Indeed, certain village farmers do not wait for the authorization of the agricultural sector supervisor before collecting the stems. Thus, the period of harvesting is not in harmony with the scheduling of collection vehicles. This explains the increase in the number of rotted stems refused coming from the PV. On the other hand, in PI, harvesters are under the authority of the head of agricultural section who endeavours to scrupulously respect the instructions of harvest thus helping in the reduction of defective stems transported to the factory.

A progressive reduction in the defective stems at the factory is observed during weeks except in the latter weeks of the different months when a fluctuation was noted. This explains on one hand that the farmers and the workers in order to have higher pay, accelerate their rate of work increasing thus the risk of obtaining defective stems and on the other hand the insufficiency of collection engines in front of the rise of the stem production. In general a decrease in the number of defective stems refused in the factory could be explained by the mastering of control systems in the plantation (Aljuburi *et al*., 2001).

The variation in the rate of ripped stems (increase) with to time is due to the rigour of the control during the harvest, the collection and the mastering of criteria of maturity.

The trend of the evolution of the rate of defective stems (green and rotted) with time can be explained by the suppression of defective stems (green or rotted) during the counting of the stems and especially during their collection in plantation. The significant fall of length of the stems peduncles collected over this period of time is due to the fact that peduncles are closely cut at the base of the stems by the harvester before the count or by the operation loader during the collection.

The trend of the rate of impurities in time is serrated during the first 9 decades reveals translates the complexity of the process of the impurities elimination. However, after a suitable treatment of the surfaces of collection consisting of the removal of any foreign body (stones, sand, twigs, grass) and ramming them to make their surface solid or cementing them, almost all impurities are eliminated, particularly in the last decades.

Different variations of the oil potential extraction (TEH) in the factory show a fall of 5% at the 24th decade indicating a bad operating condition of the production equipment at the oil mill. The TEH in the laboratory remains than that of the factory. This difference could be explained by the oil loss related to the process and the production equipments. The progressive increase in the production rate of oil is due on one hand to the rise of the rate of the ripped stems and the free fruits and on the other hand to a significant reduction in the rate of the defective stems (green and rotted) and rate of the impurities toward the last decades. In fact, the development of oil in the fruit pulp (lipogenesis) is carried out in the 4 or 6 weeks of maturation process (Amorós *et al*., 2003). Therefore, the ripped stems the free fruits which hadcompleted their lipogenesis have a very high potential. Thus, the potential of oil in a stem increases with the maturity of the fruit (Serrano *et al*., 2001). The reduction of the rate of impurities and length of peduncle of stems also contribute to increase the rate of oil extraction, because it lowers the mass of delivery and that of wastes transported. In addition, the rate of acidity being lower than 4.5% shows the percentage of rotted stems because, the process of acidification starts when the maturation of the stems is advanced and increases with the decomposition of the fruits. These various results compared with those obtained by PHCI gave the same theoretical results with regard to chemical analysis at the laboratory but differ on the level of the rate of oil extraction at the factory which is close to 21%. This difference results from the acceptance of defective stems at the entry of the factory of PHCI.

CONCLUSION

The quality control is an activity which requires the involvement of all workers. The cost effectiveness of a palm grove depends on a good organisation of the harvest and collection. The quantity of oil produced is function of the quality of the delivered stem.

Thus, the present study has enabled us through a broad sensibilization to involve all the workers in a strict control in groves at the entry of factory and upon unloading. This policy has led to significant decrease of the rate of green stems (from 15-1.3%) and rotted stems (from 14.2-1.3%). This reduction is also perceptible at the level of peduncles length (from 33.8-0.8%) and that of impurities (from 6.5-1.7%). Finally, a rise of the rate the ripped stems (from 81.6-97.4%), having for consequence an increase in the oil production in the factory from 20.1-23.7% (a profit of 3.6%).

REFERENCES

Aljuburi, H.J., H.H. Al-Masry and S.A. Al-Muhanna, 2001. Effect of some growth regulators one some fruit characteristics and productivity of the Barhee Dates Palm tree cultivar (Phoenix will *dactylifera* L.). Fruits, 56: 325-332. DOI: 10.1051/Fruit: 2001133.

Amorós, A., P. Zapata, M.T. Pretel, M.Y. Botella and M.R. Serrano, 2003. Physico-chemical and quality and physiological changes during fruit development and ripening of five Loquat (*Eriobotrya japonica* Lindl.) Cultivars. Food Sci. Technol. Int., 9: 43.

Anonymous, 1998. Memorandum of the Agronomist. 4th Edn. Paris: Collection rural Techniques in Africa, pp: 1635.

Braipson, D.S. and V. Gibson, 2007. Comparative analysis of triacyl glycerol composition, melting properties and polymorphic behaviour of palm oil and fractions. Eur. J. Technol., 109 (4): 359-382.

Cheyns, E., N. Bricas and A. Aka, 2004. Quality requirements of urban consumers and marketing chains for red palm oil in Côte d'Ivoire. Cahier Agricultures, 13 (1): 135-141.

Kalanithi, N. and W.Y. Wong, 2007. Tocotrienols and Cancer: Beyond antioxidant activity. Eur. J. Lipid Sci. Technol., 109 (4): 445-452.

Serrano, M., M.T. Pretel, M.A. Botella and A. Amaros, 2001. Physicochemical changes during date ripening related to ethylene production. Food Sci. Technol. Int., 7: 31-36.

Tan, Y., S.B. Ravigadevi, S. Kalyna and B.W. Mohd, 2007. Valorisation of Palm Oil by-products as Functional Components, 109 (4): 380-393.

Yusof, B., 2007. Palm oil production through sub-stainable plantations. Eur. J. Lipid Sci. Technol., 7 (4): 289-295.