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USING COLD PRESSING AND LOW TEMPERATURE TECHNIQUE TO PRESERVE OF FLAX SEED OIL QUALITY AND CAKE PRODUCT

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Abstract

The aim of this research was to investigate the efficiency of cold pressing and low temperature techniques to produce oil and cakeform flax seeds. Also, to evaluate the performance of the oil press machine and discuss cold press extraction is one of the methods of mechanical extraction as well as required less energy than other oil extraction techniques and also environmentally friendly. The samples were used from fresh flax seed weighted as a amount of feeding at 1, 2, 3, 4 and 5 kg at 12% db moisture content. The results with cold pressing showed according feeding ratio increased from 20, 40, 60, 80 and 100 %. operation time increased to 8, 16, 23, 32- and 38-min. addition to the temperature start at 29 ^{0}C. and increase by 31, 34, 35, 36 and 37^{0}C. Also, the oil product increased by 184, 402, 576, 775 and 981g. Cake product increased by 786, 1,576, 2,351, 3,196 and 3,991g. While with low temperature techniques using heater start temperature at 47^{0}C for all the samples the feeding ratio increased from 20, 40, 60, 80 and 100 %. the extraction time increased from 6, 12, 18, 24 and 30 min. The oil product increased by 187, 388, 581, 783 and 991 g., cake product increased by 800, 1,591, 2,394, 3,191 and 3,900 g. according feeding ratio increased from 20, 40, 60, 80 and 100 %. but the temperature decreased from 43, 42, 41, 40 and 39^{0}C after using cold pressing and low temperature techniques the oil quality have high contents of functional EPA (20:5 ω 3) and DHA (22:6 ω 3) for oil flax cake. Also, oxidizability index was 1.318.

Key words: *flax, extract, cake, time, temperature, cold pressing, and oil*

INTRODUCTION

Flaxseed is among the most important seeds in foodstuff, as it contains energy, carbohydrates, dietary fibres, proteins, monounsaturated fats, saturated diets, and many vitamins such as riboflavin, thiamine, vitamin B5, vitamin B6, folic acid, and vitamin C they also have many mineral salts, such as calcium, iron, magnesium, phosphorus, potassium, zinc, and omega-3 acid. Extracting flaxseed oil has a variety of health benefits and is used for several purposes in various industries.

Cold press extraction required less energy and also environmental friendly. High-quality oils can be obtained by enhanced production processes.

Physical properties if flax seeds was reviewed by Coskuner and Karaaba (2007) [4] reported that physical properties of flaxseed is a function of seed moisture content. The seed moisture content varied from 6.09% to 16.81% (db). In this moisture range, seed length, width, thickness, arithmetic mean diameter and geometric mean diameter increased linearly from 4.27 to 4.64 mm, 2.22 to 2.38 mm, 0.85 to 0.88 mm, 2.45 to 2.63 mm and 2.00 to 2.12 mm respectively with increasing moisture content. One thousand seed weight increased linearly from 4.79 to 5.32 g. The true density increased with moisture content from 1,000 to 1,111 kg/m^3 while bulk density decreased from 726.6 to 555.6 kg/m^3. Also, porosity values of flaxseeds increased from 27.34 to 57.44%. The highest static coefficient of friction was found on the plywood surface.

Bhatt and Prasad (2018) [3] reported that length, width, thickness and geometric mean diameter for whole seed were found to be 5.50±0.23, 2.68±0.18, 1.17±0.24 and

2.58±0.18 mm, respectively. For dehulled seed the length, width, thickness and geometric mean diameter were found to be 3.64±0.37, 2.58±0.2, 0.77±0.03 and 1.93±0.13 mm, respectively. The values of whole flaxseed were higher than the dehulled flaxseed and which may be due to removal of hull. Similar results for whole seed where the dimensions of the seed vary from 3.0 to 6.4 mm in length, from 1.8 to 3.4 mm in width and from 0.5 to 1.6 mm in thickness. At 6.09% moisture length, width, thickness and geometric mean diameter values were 4.27, 2.22, 0.85 and 2.0 mm, respectively

The importance of flax seeds was reviewed by Jhala and Hall (2010) [10]. Cultivar development of flax is currently focused on enhancing the oil content. Flax seeds are also rich in soluble and insoluble fibers and lignans, makes it useful as a dietary supplement. The residues remaining after the oil extraction from linseed contains about 35-40% protein and 3-4% oil, a rich source of feed to livestock like cattle and buffalo.

Based on the information, Singh (2012) [18] affirmed that it is evident that flaxseed is the richest source of α-linolenic acid oil and lignin. It is a considerable potential source of high quality protein, soluble fibers, and phenolic compounds. The flaxseed has tremendous potential to be used as human food, animal feed, and good quality fibers.

Goyal et al. (2014) [7] were focused on the evidences of the potential health benefits of flaxseed through human and animals' recent studies and commercial use in various food products.

Kaur et al. (2018) [11] concluded that flax seeds oil (*Linum usitatissimum*) is an important oilseed crop which has gained importance over the last few decades due to its unique nutrient profile. It is evident from several studies conducted that flaxseed carries functional ingredients and provide health benefits. Omega-3 fatty acid, and dietary fibers are major bioactive components of flaxseed which can be delivered through value added products. Flax seed consumption in the diet prevents serious diseases like coronary diseases, cancer, diabetes, obesity, gastrointestinal, renal and bone disorders.

Shafie et al. (2019) [16] revealed that linseed is a dietary source of plant. Their results show that the individual components of linseed produce greater potential therapeutic responses in rats with metabolic syndrome than whole linseed. They suggested that the reduced responses indicate reduced oral bioavailability of the whole seeds compared to the components.

Chemical Properties of Flax seeds was reviewed by Gutiérrez et al. (2010) [8] pointed out that oil extracted from flaxseed contained 51.86% linolenic, 16.34% linoleic and 20.98% oleic acid. Fractioning of defatted flaxseed cake produced a polyphenol content of 0.73 mg GAE g-1 extract and a protein isolate of considerable purity, 53.15% yield with 0.78 g of albumin equivalent g^{-1} protein isolate. Additionally, a polysaccharide was isolated with low protein content as impurity, 10.71% yield with 1.37 mg of glucose equivalent per gram of polysaccharide.

Ali and Watson (2014) [1] studied the effect of moisture content on oil yield making a comparison between a mechanical oil expeller, organic solvent extraction, organic solvent and microwave assisted, organic solvent and ultrasonic assisted, and combined microwave and ultrasonic with organic solvent. The maximum oil yield % wt/wt from these techniques was 22.6%, 36.3%, 10.0%, 42.0% and 27.8%, respectively.

Yilmaz and Gűneşer (2017) [20] compared the cold press with hexane-extracted lemon seed oils and determined their physicochemical and thermal properties. Cold pressing yielded significantly lower oil (36.84%) than hexane extraction (71.29%). In addition, the concentrations of free fatty acids, peroxides, and p-anisidine were lower in the cold pressed oil.

Al Juhaimi et al. (2018) [2] reported that the highest total phenol contents (2.36 mg gallic acid equivalent/100 g) were observed in pistachio oils obtained by cold press. The oleic acid contents of cold pressed and soxhlet extracted oils were between 19.88 (walnut) and 69.43% (pecan) to 19.07 (walnut) and 68.53% (pecan), respectively. The linoleic acid contents of nut oils from cold press system vary between 12.78 (hazelnut) and

63.56% (walnut), whereas in case of soxhlet extraction, it changed between 11.78 (hazelnut) and 62.41% (walnut).

Piva et al. (2018) [14] found that there were no significant differences among the ω-3, 6 and 9 fatty acids from linseed oil obtained using different extraction methods. Only the acidity of linseed oil extracted by subcritical propane (0.956 %) showed statistically significant differences among the physicochemical parameters. Extraction using organic solvent (Soxhlet) produced 36.12% yield. Extraction using subcritical propane at 107 Pa and 40°C for 1.5 h produced a higher yield (28.39%) than pressurized ethanol (8.05 %) treated by similar conditions.

Green Oil Extract was reviewed by Tanzi et al. (2012) [19] described a green and original alternative procedure for the extraction of oil from microalgae. The described method was achieved in two steps using Soxhlet extraction followed by the elimination of the solvent from the medium using Clevenger distillation in the second step. Oils extracted from microalgae were compared in terms of qualitative and quantitative determination. No significant difference was noticed between each extract, revealing that the proposed method is green, clean and efficient.

Sahad et al. (2014) [15] provided an overview of the use of green solvents for oil extraction from natural products using soxhlet extraction and supercritical fluid extraction (SFE) methods. In terms of qualitative and quantitative determinations on the extracted oils, the use of green solvents was comparable with n-hexane. For soxhlet extraction method, the integration of microwave application into the soxhlet at their optimum conditions has shown improvement in oil yield, oil quality, solvent consumption and extraction time.

Kumar et al. (2017) [12] assessed the potential of a novel green technology for oil extraction from various oilseeds. As each oilseed comprises different architecture, the process needs to look for suitability of technology in economical and technical ways. Green solvents are effective in consumption of solvent, reduction of downstream processing steps (reclamation of solvent) causing no effect to other desired products.

Cold and hot Extract was reviewed by Mwithiga and Moriasi (2007) [13] concluded that oil yield from the various operations was measured and expressed as a percentage of the original mass of crushed seeds. It was found that oil yields increased linearly with increasing the pressure as the compression pressure was increased from 40 to 80 kgf/m^2 and that oil yield also increased linearly when the duration of pressing increased within the time range of 6 to 12 min.

Hesham et al. (2016) [9] mentioned that cold press method is one of the best methods to extract essential oils. This process is used for most carrier oils and many essential oils. This process ensures that the produced oil is 100% pure and retains all the properties of the plant. It is a method of mechanical extraction where heat is reduced and minimized throughout the batching of the raw material. The cold press method is also known as a scarification method.

Siger et al. (2017) [17] concluded that cold-pressed oils produced from rapeseeds with a 5% moisture content were characterized by higher levels of tocopherols and plastochromanol-8. In the case of hot-pressed oils, the highest levels of tocopherols were found in oils produced from seeds with a7.5% moisture content, and the greatest amount of PC-8 (more than 4 mg/100 g) was found in oils produced from seeds with a 10% moisture content.

Çakaloğlu et al. (2018) [5] stated that cold press extraction is one of the methods of mechanical extraction which consumes less energy than other oil extraction techniques and also environmental friendly. It is used to extract oil from a range of matrices and is produced especially in the oil production from oilseeds. High-quality oils can be obtained by performing production at low temperatures using cold press method. It has an environmentally friendly use with no solvents. In other words, the cold-press extraction does not involve either heat or chemical extraction.

Parameters Affecting oil Extraction was reviewed by Fouda (2018) [6] showed that more than 18 % of oil fish per one kg of salmon wastes. The oil weight from by-products increased with increasing pressing

time and oil yield also increased. The oil extraction increased and characterization of quality.
This study aimed to use cold pressing and low temperature techniques for producing high quality oil and cake from flaxseeds and assess the effect of feeding rate and operating time on oil yield.

MATERIALS AND METHODS

Experiments were conducted to test the cold pressing (using oil extraction machine with out heater) and low temperature techniques (using oil extraction machine with heater at constant temperature 50 C^{o}) to preserve of flax seed oil quality and cake product

Sampling

Flaxseeds harvested from Gimiza Research station variety Evona.

Table 1. Physical Properties of flax seeds:

Properties	Whole seed
Length (mm)*	5.50±0.23
Width (mm)*	2.68±0.18
Thickness (mm)*	1.17±0.24
Geometric mean diameter (mm)	2.58±0.18
Sphericity (%)**	42.31±0.49
True density (kg/m^{-3})	1,025.33±2.89
Bulk density (kg/m^{-3})	696.67±1.15
Angle of repose (°)	26.29±0.46
Rupture force (N)	41.97±0.38
Deformation (mm)	0.37±0.13
1,000 seed mass (g)	7.38±0.14

Source: Authors' determination.

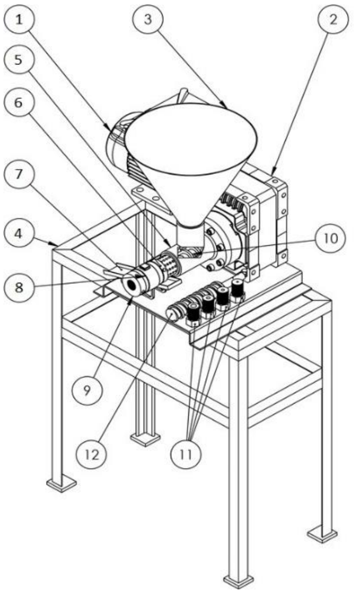
Table 2. Chemical Properties of flax seeds

Properties	Whole seed
Moisture (%)	5.08±0.45
Fat (%)	39.51±1.05
Protein (%N×6.25)	21.38±0.38
Ash (%)	2.83±0.20
Crude fiber (%)	3.57±0.48
Carbohydrate (%) **	28.04±0.36**
Trypsin inhibitors (TIU/g)	29.33±0.23
Flavonoid compounds(mg/100g)	39.99±1.41
Total phenolics as gallic acid (mg/100g)	230.0±1.04
Phytic acid (mg/100 g)	770.0±0.5

Source: Authors' determination.

The oil extraction machine

The oil extraction machine was used to terminate low of extraction efficiency with bad quality seeds for extraction oil and cake. The oil extraction machine, which used in this work, is illustrated schematically in Fig. (1).



No.	Part Name
1	Motor
2	Worm gear speed reducer
3	Hopper
4	Chassis
5	Chemise
6	Pushing
7	Oil outlet
8	Heater
9	Mold
10	Screw type 1
11	Spare parts
12	Screw type 2

Fig. 1. The oil extraction machine
Source: Authors' drawing.

The extraction machine, consists mainly of press screw pitch of single flight. The oil extraction machine consists of the following parts:

1- Machine base

Machine base was made from U shape steel bars having width of 50 mm, length of 30 mm, and thickness of 10 mm, the base has dimensions of 700 mm length, 350 mm width and 810 mm height.

2-Feeding hopper

The feeding hopped of flax seed made from steel sheets has a thickness of 1mm, and upper diameter of 355 mm, and bottom diameter of 64.5 mm, the height of feeding hopper was 370 mm. It was used to feed the flax seeds into the extraction barrel.

3-Extraction barrel

The extraction barrel has a cylindrical shape of 300 mm length, and 70 mm diameter in the extraction zone and 64.5 mm in the feeding zone with 2 mm thickness, both cylinders were connected together by a plate which has a diameter of 176 mm using four long bolts of 16 inch, the cylinder opening from both sides the front end fixed with the extraction head, and the back end closed by bearing plate has a diameter of 116 mm, and thickness of 100 mm. There are 8 holes of 12 mm diameters, for oil output. The extraction cylinder has eight holes for oil output has diameter of 8 mm. and the barrel unit constricted with the machine base by four long bolts of 19 inch.

4-Extraction screw press

The extraction screw press, has a length of 360 mm, 30 mm diameters, 40 mm diameters in bearings section, and 33.5 mm pitch. The screw tooth has a width of 10 mm, and tooth height of 12 mm.

5-Extraction head

Compressing head has a conical with a big and small diameters of 116 and 95mm.

6- Heater

Heater placed on the end of extraction screw to start with room temperature to 50 C°

7- Power transmission

Power transmission and electric motors: The power transmitted from 4 kW electric motor, which rotates at 1,400 rpm 3 phase. The electric motor shaft has a pulley of 120 mm in diameter, connected with the screw pulley which has a diameter of 100 mm by a 17 inch rubber belt.

Factors under study

1- Five different mass of seeds feed at 1, 2, 3, 4 and 5 kg. at 12% moisture content (db).

2- Cold pressing start with room temperature

3-Low temperature techniques pressing under to 50^0C.

Measurements

Oil mass in sample was determined five times for 1, 2, 3, 4 and 5 kg. of Flaxseeds by-products by cold pressing (cold pressing after 8, 16, 23, 32 and 38 min) and low temperature techniques pressing after (6, 12, 18, 24 and 30 min).

Oil extract (g) = Extract oil from flax by product sample (1,000 g.)

Cake product (g) = Cake product from flax by product sample (1,000 g.)

O.I. – oxidizability index, it was calculated using the formula:

OI = (0.02·C18:1 + 1·C18:2 + 2·C18:3)/100.

RESULTS AND DISCUSSIONS

The small production expeller using cold pressing and low temperature techniques, the relationship between the amount of seeds amount were used and the extraction times for cold pressing start with room temperature and low temperature techniques pressing under to 50^0C.

Regarding to Fig. 2 the operation time for small expeller increased from 6 to 30 min. with amount of seeds increased from 1 to 5 kg. for low temperature techniques pressing. While when used cold pressing the operation time for small expeller increased from 8 to 39 min. the amount of seeds amount were increased from 1 to 5 kg. for cold pressing.

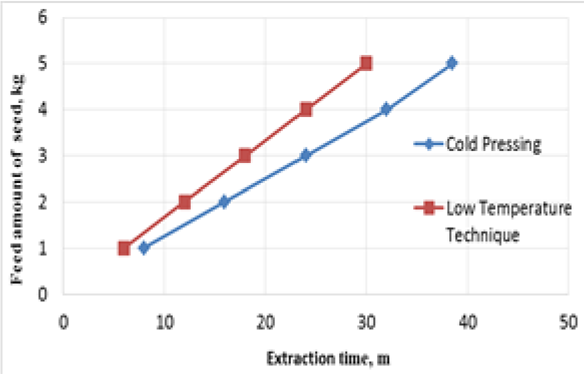


Fig. 2. Effect of use cold pressing and low temperature techniques on the amount of seeds amount and the extraction times
Source: Authors' determination.

From Fig. 3 and 4 showed that, when the operation time for extract increased from 6 to 30 min. the oil extracted increased from 187 to 991 g. Also cake product increased from 800 to 3,900 g. for low temperature techniques pressing.

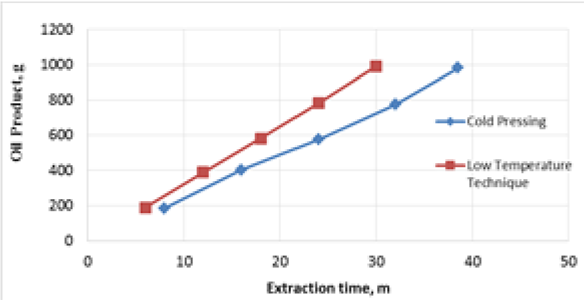


Fig. 3. Effect of use cold pressing and low temperature techniques on the oil extracted and the extraction times
Source: Authors' determination.

While when used cold pressing the operation time for small expeller increased from 8 to 39 min. the amount of seeds amount were increased from 184 to 982 g.

Also cake product increased from 786 to 3,991 g. for cold pressing.

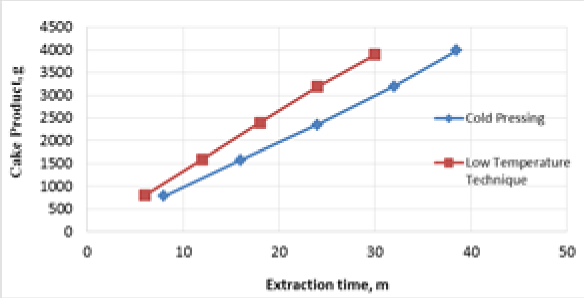


Fig. 4. Effect of use cold pressing and low temperature techniques on the cake product and the extracted times.
Source: Authors' determination.

From Fig. 5 and 6 showed that, the temperature increased by compressed act on the extraction screw press from 31 to 37^{0}C when amount of seed feed increased from 1 to 5 kg. oil extract increased from 184 to 982 g. Also cake product increased from 800 to 3,900 g. for cold pressing. While when used techniques pressing the temperature start with constant 50^{0}C by heater act on the extraction screw press but the temperature decreased by oil cooling act from 44 to 39^{0}C when amount of seed feed increased from 1 to 5 kg. the amount of oil extract increased from 187 to 991 g. Also cake product increased from 786 to 3,991 g. for low temperature .

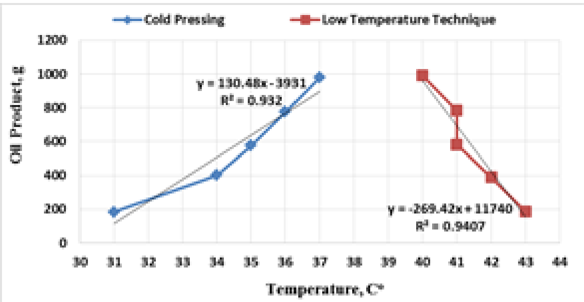


Fig. 5. Effect of use cold pressing and low temperature techniques on the oil extracted with the temperature.
Source: Authors' determination.

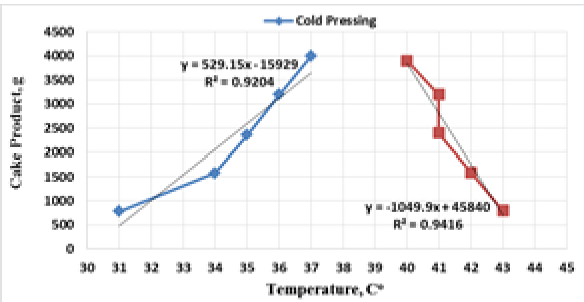


Fig. 6. Effect of use cold pressing and low temperature techniques on the cake product with the temperature.
Source: Authors' determination.

Fatty acids composition

To extract the highest quality oil and maintain sensitive and important components, the most important of which are Omega-3 and Omega-6 and not to break the bonds that cause rapid oxidation of the oil.
The results in Table 3 indicated that the major saturated fatty acids from flaxseeds is polmetic acids (C16:0) which represented about 4.85 %. the second one is myristic acid (C14:0) 0.03 % followed by stearic acids (C18:0) 4.94 %. The predominant MUSFA is oleic acids (C18:1) which is represented 16.94 % Lenolic Acid (C18:2 ω6) 13.63 % and Linolenic Acid (C18:3 ω3) is 58.92 %. These types of FA represented more than 72 % of ω3 and ω6 fatty acids, these fatty acids playing very important jobs in healthy nutrition.

Table 3. Oil extracted components from flaxseeds

Fatty acid	Test Methods	Total fatty acids
Myristic acid C14:0	ISO 12966 – 2 2011	0.03
Palmitic Acid C16:0		4.85
C16:1		0.05
C17:0		0.06
C17:1		0.03
Stearic Acid C18:0		4.94
Oleic Acid C18:1		16.94
Linoleic Acid C18:2 ω6		13.63
Linolenic Acid C18:3 ω3		58.92
Arachidic acid C20:0		0.17
C20:1		0.14
C22:0		0.13
C24:0		0.10
Oxidizability index, O.I.		1.318

Source: Authors' determination by Food Technology Research Institute laboratory, Department of Oil Research, Agricultural Research Center.

Flax seed oil extracted by cold pressing its content of long chain omega-3 polyunsaturated fatty acids (PUFA), such as (DHA), (DPA) and eicosapentaenoic acid (EPA), which are currently highly valued for their prophylactic and therapeutic properties in nutritional and health fields. High contents of functional EPA (20:5 ω 3) and DHA (22:6 ω 3) in the oil as showing in Table 4 and 5**.**

Table 4. Oil extracted Acidity and Peroxide value at cold pressing under to 39 Co.

Test Methods	Acidity (as Oleic Acid) %	Peroxide value (MeqO2/kg oil)
A.O.A.C 2005	0.79	3.31

Source: Authors' determination by Food Technology Research Institute laboratory, Department of Oil Research, Agricultural Research Center.

Table 5. Oil extracted Acidity and Peroxide value at cold pressing Low temperature under to 50 Co.

Test Methods	FFA value (Acid number	Peroxide value (MeqO2/kg oil)
A.O.A.C 2005	0.05±0.004	4±0.03

Source: Authors' determination by Food Technology Research Institute laboratory, Department of Oil Research, Agricultural Research Center.

CONCLUSIONS

The results show the effect of the extraction method and the effect of the limited temperature increase on the quantity of oil and cake, addition to low extraction time. Also keep the quality oil seed extraction. The samples were used from fresh flax seed weighted as a seed mass feed at 1, 2, 3, 4 and 5 kg at 12% db moisture content.

At cold pressing the temperature start at 29 ^{0}C. The results discovered the operation time increased to 6, 12, 18, 24 and 30 min The oil product increased by 184, 402, 576, 775 and 981g. The cake product increased by 786, 1,576, 2,351, 3,196 and 3,991g. Also, temperature start on 29^{0}C for all samples and increased from 31, 34, 35, 36 and 37^{0}C according seed mass feed increased from 1, 2, 3, 4 and 5 kg.

At low temperature techniques used heater temperature start on 50^{0}C to retch to 46^{0}C on the extraction screw press but the temperature decreased by oil cooling act from 43, 42, 41, 40 and 39^{0}C the extraction time increased from 8, 16, 23, 32 and 38 min

The oil product increased by 187, 388, 581, 783 and 991g. The cake product increased by 800, 1,591, 2,394, 3,191 and 3,900 g. Also, temperature start on 29^{0}C for all samples and increased from 31, 34, 35, 36 and 37^{0}C according seed mass feed increased from 1, 2, 3, 4 and 5 kg.

With the aim of to obtained oil flaxseed with high quality and preservation the flaxseed contains compounds and sensitive bonds and you obtained the cake flaxseed riches with energy, carbohydrates, dietary fibres, proteins, monounsaturated fats, saturated diets, and many vitamins such as riboflavin, thiamine, vitamin B5, vitamin B6, folic acid, and vitamin C, and many mineral salts, such as calcium, iron, magnesium, phosphorus, potassium, zinc, and omega-3 acid, the cold extraction oil the best method and when you need to decreased the time of extraction use heater can increase heat under to 50^{0}C.

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