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Characteristics Analysis of Cooking Oil Extracted from Oil Expeller

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ABSTRACT: The study presented in this project report focuses on the comprehensive characteristics analysis of cooking oil extracted from an oil expeller, specifically designed and manufactured for small-scale oil extraction. Cooking oil is a fundamental component of our daily culinary activities and a vital commodity in the food industry. Understanding the characteristics and quality of cooking oil is crucial to ensure its nutritional value, taste, and overall safety.

The project begins with a detailed overview of the importance of cooking oil in daily life and its significance in various industries, emphasizing the need for effective oil extraction techniques. A review of the existing methods and technologies for oil extraction is conducted, highlighting the advantages and drawbacks of each approach. The oil expeller machine, designed and manufactured as part of this project, is introduced and its operational principles are elucidated.

I. INTRODUCTION

Groundnut (Arachis hypogaea L.) is a native to eastern region of south America. It is grown as an annual crop purposely for its edible oil and protein rich seeds. The groundnut is a herbaceous plant with many cultivars, common in the united states, grow up to 30-46 cm high. Runner varieties, the most common in the West African countries are shorter and run along the ground for 30-60 cm (Atasi et al., 2009). The peanut plant produces yellow, orange or white flowers which produce 'pegs', characteristic floral structures which sink into the ground to grow the pod. The pods can reach up to 10 cm in length and can contain between 1 and 5 seeds, depending on the varieties (Krapovickan et al., 2007). Vegetable oils are widely consumed domestically in Nigeria and other parts of the world. It is used primarily as a cooking and salad oil. Studies have shown that groundnut oil contains potassium and sodium and is a good source for calcium, phosphorus and magnesium. It also contains thiamine, vitamin E, selenium, zinc and arginine. Groundnut oil is of high quality and can withstand higher temperatures without burning or degradation (Nkafamiya et al., 2010).

Extraction Process

Extracted Oil

Fat and oils have nutritional importance because they form one of the major classes of food. Oils are used in a variety of ways at both domestic and industrial levels. They are used for food texturing, baking purposes, and frying and also used in some industries in the manufacture of soap, detergents, cosmetics and paints. In plants, oil is deposited in the endosperm of the seeds along with carbohydrates where they jointly feed the embryo (Birnin Yauri and Garba, 2011). Seed oils are important sources of nutritional oils, industrial and pharmaceutical importance. There are many vegetable

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oils derived from various sources, these include the vegetables oils such as cotton seeds, groundnut seeds, soybean, and sun flower oils.

II. METHODOLOGY

SAMPLE COLLECTION: The first step in the methodology is the collection of cooking oil samples obtained from various oil expellers. these samples will represent a range of sources, including different oilseeds and processing conditions, to ensure a comprehensive assessment of cooking oil characteristics.

PHYSICAL PROPERTY ANALYSIS: The project will begin with an analysis of the physical properties of the cooking oil. this will involve the measurement of attributes such as color, odor, and viscosity. the analysis will be conducted using standard laboratory techniques and equipment, ensuring accurate and reproducible results.

CHEMICAL PROPERTY ANALYSIS: The chemical properties of the cooking oil will be assessed, including free fatty acid content, peroxide value, and any other relevant chemical parameters. these analyses will provide insights into the stability and safety of the cooking oil.

NUTRITIONAL ANALYSIS: The nutritional attributes of the cooking oil will be determined. fatty acid composition, vitamin content, and other key nutritional elements will be assessed using established methods. this analysis will help evaluate the oil's nutritional value and its potential impact on consumer health.

INFLUENCE OF PROCESSING PARAMETERS: To understand the influence of processing parameters, controlled experiments will be conducted. the oil expeller machine will be operated under varying conditions, including different temperatures, pressures, and extraction times. cooking oil samples will be collected at each parameter setting for subsequent analysis.

COMPLIANCE WITH STANDARDS: The project will compare the results of the analysis with established quality and safety standards for cooking oil. this step is essential to ensure that the oil meets the required industry and international guidelines.

DATA ANALYSIS: The data obtained from the physical, chemical, and nutritional analyses, as well as the influence of processing parameters, will be systematically analyzed. statistical methods and software tools will be used to draw conclusions, identify correlations, and extract meaningful insights from the data.

RECOMMENDATIONS FOR OPTIMIZATION: Based on the analysis and findings, the project will provide recommendations for optimizing the oil extraction process using an oil expeller. these recommendations may involve adjustments to machine design, operational procedures, or environmental conditions to improve the quality and efficiency of oil production.

PROMOTION OF SUSTAINABLE PRACTICES: As a final aspect of the methodology, the project will consider the environmental impact and sustainability of the oil extraction process. recommendations for more sustainable practices will be proposed to reduce waste, energy consumption, and environmental harm.

Physical Analysis of Oil Determination of Oil yield

The oil from groundnut seeds was obtained by complete distillation. The oil which was obtained by complete distilling of most of the solvent on a heating mantle was transferred to a beaker. The beaker was then placed on water bath for complete evaporation of solvent for about 2 hours and volume of the oil was recorded and expressed as oil content (%) (Aliyu et al., 2015).

Oil content (%) = (Oil weight /Sample weight)*100 Determination of Specific Gravity (Relative Density)
The sum of 10ml of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and oil was measured; the weight of the oil was then obtained by subtracting the weight of the cylinder from the weight of the oil and cylinder (Aliyu et al., 2015). The relative density of the oil was obtained using equation below:
Density of oil = Where W1 = weight of empty measuring cylinder + oil. Wo = weight of measuring cylinder, Vo = volume ofoil used.

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Chemical Analysis of oil Determination of Acid Value

Exactly 2.0g Ba $(OH)_2$ was added to 0.1M KOH solution and left for 5 min. The solution was cooled, filtered and stored in a plastic bottle. The resulting solution was standardized using 0.10M $KHC_8H_4O_4$ (potassium hydrogen phthalate) solution. The solvent mixture was neutralized with standard 0.1M KOH solution until persistent faint pink colour appeared. Then 1.25g of the oil was transferred into a 250ml conical flask and 125ml of the solvent mixture was added to the sample. This was dissolved by agitation and warming on a steam bath. At this point the pink colour disappeared and a clear solution was obtained. The solution was titrated against the 0.1M KOH solution. The end point was obtained by the restoration of the pink colour. The procedure was repeated three times and the average end point was obtained (Birnin-yauri and Garba, 2011).

Determination of Peroxide Value

Peroxide value is used as a measure of the extent to which rancidity reactions have occurred during storage. The quality and stability of fats and oils can be indicated by using the peroxide value. In the study, soybean oils and palm oil showed the lower peroxide values in the range of 1-2 meq O_2/kg oil which indicates a relatively good quality of these oils. On the other hand, mustard oils, castor oil, almond oil, olive oil showed higher the values in the range of 5-13 meq O_2/kg oil. There is a successive increase in peroxide value indicates the rancidity of oils due to relative higher oxidation in oils. Peroxide value ranges are closely related to the standard value of 10 meq O_2/kg as specified (Sabir et al., 2016).

Determination of Iodine Value

The iodine value of oils was determined according to AOAC method (1984). About 0.25 g oil sample was taken in a conical flask and dissolved in 10 ml CCl_4. Similarly, 30 ml hanus solution was added and the mixture was allowed to stand for 45 min in dark with occasional shaking. 10 ml 10% KI solution and 100 ml distilled water were added and washed down any free iodine on the stopper. The iodine was titrated with previously standardized $Na_2S_2O_3$ solution which added gradually with constant shaking until yellow solution turned almost colorless. Few drops of starch indicator was added and titration was continued until blue color entirely disappeared. Bottle was shaken violently so that any iodine remaining in solution in the CCl_4 might be taken up by the KI solution. The volume of $Na_2S_2O_3$ solution required for the experiment was noted. A blank experiment was conducted along with the sample. Percent weight of iodine absorbed by the oil sample was calculated by the following formula: 1 ml 1N $Na_2S_2O_3$ = 0.127 g I_2 (B-A) × N × 0.127 × 100 Iodine value = W B = ml of 0.1N $Na_2S_2O_3$ required by blank A = ml of 0.1N $Na_2S_2O_3$ required by oil sample N = Normality of $Na_2S_2O_3$ W = Weight ofoil in g.

Determination of Saponification Value

The saponification value is determined by taking 1.0 g of oil sample in a conical flask with addition of 25 ml 0.5 N alcoholic KOH heated under a reserved condenser for 30–40 min to ensure that the sample was fully dissolved. After cooling the sample, phenolphthalein was added and titrated with 0.2 N HCl until a pink end point was reached (Sabir et al., 2016). Saponification value = W B= ml ofHCl required by blank T= ml of HCl required by oil sample N= Normality of HCl W=Weight of oil in gm.

Determination of the Free Fatty Acids

To 20ml of ethanol-diethyl ether (1:1 v/v) mixture, 2ml of 1% phenolphthalein solution was added and the mixture was neutralzed using 0.10M NaOH solution. Then 5g of each oil sample was added to the neutralized mixture and titrate against 0.10M NaOH solution with constant shaking until a pink colour developed and persisted for 15 minutes. The titre values were used to obtain the free fatty acid value (Birnin Yauri and Garba, 2011).

Statistical Data Analysis

Data obtained were statistically analyzed using SPSS Statistical Software platform. Results were expressed as Mean ± Standard deviation of the triplicate values.

Introduction to the oil Expeller

The Groundnut oil expelling machine is an important device for oil recovery from groundnut seed in a screw mill, direct firing of barrel and pressing with a motor driven oil expeller. Expeller uses a horizontal rotating metal screw, which feeds oil-bearing seeds into a barrel shaped outer casing with perforated walls. The seeds are continuously fed to the expeller, which grinds, crushes and presses the oil out as it passes through the machine. The machine uses friction and continues pressure from the screw drives to move and compress the seed material. The pressure ruptures the oil

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cells in the product and oil flows through the perforation in the casing and passes through the oil outlet and is finally collected with oil receiving container underneath. Raw materials enter one side of oil expeller and waste products exit the other side. The residue of the material from which oil has been extracted, are sent out through the cake outlet.
The Bigger units which process greater quantities of oil are available for use in larger mills. The percentage of oil extracted by expellers is nearly 90% depending upon the type and kind of products as well as the expeller being employed. The friction created by the products being pressed wears down the worm shaft and other internal parts, and also have the tendency of creating problem or causes failure of main shaft. The need to produce a groundnut oil expelling machine arose even in the distant past due to the need to produce oil for domestic and commercial uses. Some old oil expellers are shown below figure

History of Oil
The Chinese was the first people to expel oil from seeds. The first man sampling a seed of wild grass would have cracked it with his teeth or nail and then after placing the bulk of the grains or nuts in a hollow of a natural stone, he pounded it with a stone and expels the oil used for cooking and other purposes. Because the process of physical change occurring in each grain or nut was complex and numerous nuts were simultaneously processed, he could not regulate them directly. His work was only a simple mechanical action repeated monotonously.

The Major Components Used Are
Screw shaft: It grindes, crushes the oil bearing seeds and it moves cake and oil forward. The material used for screw shaft is304 food-grade stainless steel.

Shaft casing: It is a cavity which is used to maintain pressure and friction to extract oil from peanut seeds. The materialused for screw shaft is 304 food-grade stainless steel.

Hopper: It acts as feeding device through which the raw materials are fed into the screw housing. The hopper is madeby using stainless steel sheet metal.

Industrial Motor with Gear: The motor used in the model is 0.5 HP ,1250 RPM ,220 Volts 50Hz,350 watts, Three phasecurrent and attached gearbox.

Base Frame: It is used to support the total load of the system comprising of various components like motor, screw, screwcasing, etc. construction of the machine base frame by using 1.5 inches square pipe.

Heater: The moisture content present in the oilbearing seeds is evaporated, which results in breakdown of the emulsionform of the fat and helps in releasing more oil droplets. So the cake obtained is oil free and fully dried.

Tray: Tray is used to collect the cake obtained at the cake outlet, and it made by using sheet metal.

Fabricated Model

III. EXPERIMENTAL RESULTS

FSSR Parameters of Groundnut oil
The Food Safety and Standards Authority of India (FSSAI) sets specific standards for groundnut oil (also known as peanut oil) under the Food Safety and Standards Regulations (FSSR). These standards ensure the quality and safety of

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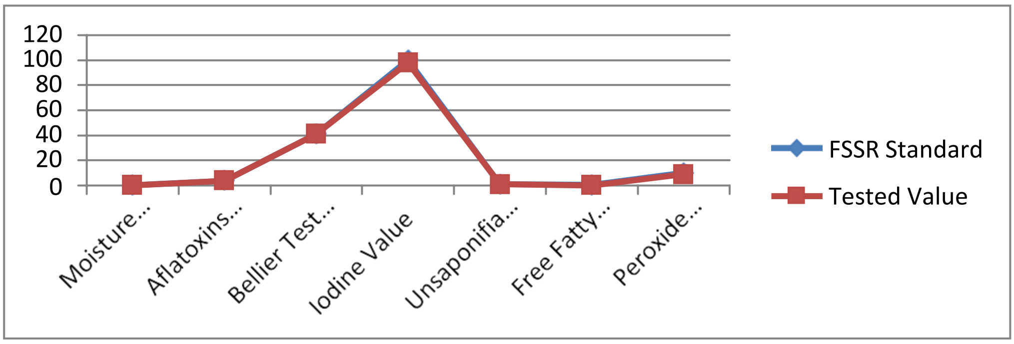
the oil for consumer use. Here are the key parameters and their standards.
FSSR Standard Parameter for GrondnutOil

Parameter	**Minimum Value**	**Maximum Value**	**FSSR Standard**
Moisture and Insoluble Impurities (%)	0	0.2	<= 0.2%
Refractive Index at 40°C	1.459	1.467	1.459 - 1.467
Saponification Value	188	196	188 - 196
Iodine Value	85	100	85 - 100
Unsaponifiable Matter (%)	0	1.0	<= 1.0%
Free Fatty Acid (%)	0	0.3	<= 0.3%
Peroxide Value (meq/kg)	0	10	<= 10 meq/kg
Bellier Test (°C)	39	41	39 - 41

Tested Values of Groundnut Oil

Parameter	**FSSR Standard**	**Tested Value**
Moisture and Insoluble Impurities (%)	0.2	0.18
Aflatoxins (ppb)	4	4
Saponification Value	196	193
Iodine Value	100	98
Unsaponifiable Matter (%)	1	1
Free Fatty Acid (%)	0.3	0.28
Peroxide Value (meq/kg)	10	9
Bellier Test (°C)	41	41



Characteristics of Groundnut Oil

FSSR Parameters of Coconut oil

The Food Safety and Standards Authority of India (FSSAI) has established specific standards for coconut oil under the Food Safety and Standards Regulations (FSSR). These standards are intended to ensure the quality and safety of coconut oil for consumer use. Here are the key parameters and their standards

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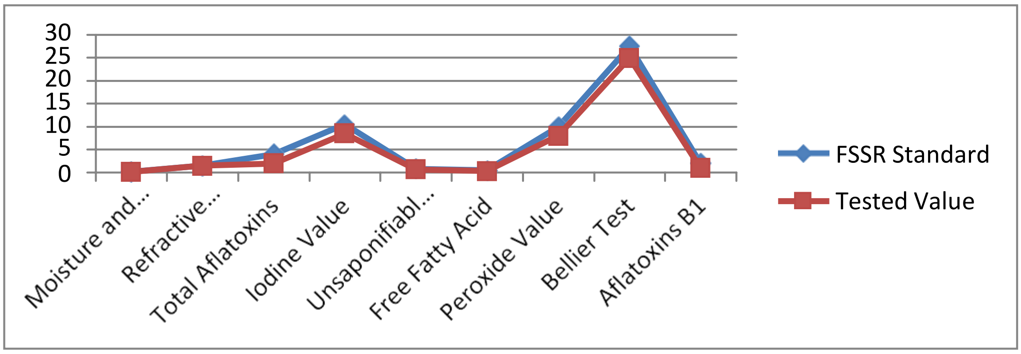
FSSR Standard Parameter For Coconut Oil

Parameter	Minimum Value	Maximum Value	FSSR Standard
Moisture and Insoluble Impurities	0	0.2	0.2%
Iodine Value	7.5	10.5	7.5 - 10.5
UnsaponifiableMatter	0	0.8	0.8%
Free Fatty Acid	0	0.5	0.5%
Peroxide Value	0	10	10 meq/kg
Bellier Test	23	27.5	23 - 27.5
Polenske Value	13	-	>= 13
Aflatoxins B1	0	2	2 ppb
Total Aflatoxins	0	4	4 ppb

Tested Values Of Coconut Oil

Parameter	FSSR Standard	Tested Value
Moisture and Insoluble Impurities	0.2	0.18
Refractive Index at 40°C	1.45	1.449
Total Aflatoxins	4	2
Iodine Value	10.5	8.5
Unsaponifiable Matter	0.8	0.7
Free Fatty Acid	0.5	0.3
Peroxide Value	10	8
Bellier Test	27.5	25
Aflatoxins B1	2	1



Characteristics of Coconut Oil

IV. CONCLUSION

A groundnut oil expeller was designed, fabricated using locally available and easily accessible materials, and tested for groundnut oil extraction. The relative performance test result shows that the machine maintained high level of oil extraction characteristics in terms of cake quality and oil quality. The expeller is powered by a half HP electric motor,

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and has a average oil yield and extraction efficiency of 72.9%. The machine is cheap and could easily fit into poor people , small and medium scale groundnut oil extraction in the rural and urban communities. The machine is easy to fabricate and safe to operate, and easy to repair and maintain and has a low energy consumption rate and do not pollute the environment and also provide livestock feed mill.

Scientific information and knowledge on less familiar or under-utilized oils encourage the utilization of both nutritional and industrial potential. The result of physico-chemical properties further confirmed the quality of the extracted oil for cooking and industrial potentials. Thus blending is a good choice by which can manufacture edible oils of good characteristics and ensure their quality. The food value of the oils and blends can also be predetermined to provide the safest food to consumers. The blend of oils that results from the combination has a good frying and acceptable sensory qualities. The advantages of using blending as a means of modifying oils is that it is easy and costs less.

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