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Technology for production of edible grade de-oiled cake from groundnut and its diversified use in baked products

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Abstract
Peanut (*Arachis hypogaea* L.) is a biennial crop grown as the strongest and main element in the Mediterranean region and is assigned to hepea family. Groundnut cake and a by-product of oil extraction is an excellent livestock feed because of its high protein content cake contains 45-60 protein, 22- 30% carbohydrate, 3.8-7.5% crude fiber and 4-6%minerals. So the development of a new protein rich product such as bakery products etc. Methodology Cleaning, Grading and preparation of peanut meal flour and also we are find the physical and chemical properties of peanuts. The main objectives to determine capacity and efficiency of peanut decorticator and testa remover, to produce edible grade deoiled cake from groundnut. Conclusion the oil expulsion was carried out after removal of hull and testa, so the de oiled cake obtained is edible in nature with 13% fat (after first pass) and 35% protein. As the level of de oiled peanut cake flour and pearl millet flour increased, the expansion decreased and Ash, fat and protein levels increased with increase in level of incorporation of de oiled peanut cake flour.

Keywords: groundnut, fat extractor

Introduction

Peanut are fit to be eaten and resembles like nut seeds of the plant and it is to be family of pea Arachishypogaea, which grow under the ground skin, skin is thin and brown in Colour. Groundnut gives edible and pleasant tasting oil for direct human consumption and is used as salad oil or for cooking purpose. China is number one producer of peanut and then India follows i.e, 2nd position. Vegetable oils are obtained by pressing, grinding of forcing and cooking or extraction of solvent of the raw materials. Edible oil can be extracting from oil seed and most common method is mechanical pressing of oilseeds. This method ensures extraction of a non-contaminated, protein-rich low fat cake at a relatively low cost. The per capita consumption of vegetable oils is raising continuously sur passing 14 kg/year during 2010-11. This is almost 40% more than the recommended fat intake by ICMR to meet the nutritional needs of India's population. That it contains 20-26% crude protein and makes an excellent source of supplementing proteins in the diet. Groundnut has high vitamins and minerals contents like iron, phosphorous and calcium. It also has a high content of crude fiber and high level of sulphur containing amino acids which are limited in cereals. The cake contains 45-60 protein, 22- 30% carbohydrate, 3.8-7.5% crude fiber and 4-6%minerals (Desai *et al.*, 1999) [11]. Cake blends help in production of Defetted groundnut flour (DGF) very easily and increase the nutritive value of wheat and other flour (Purohit and Rajyalakshmi, 2011) [2]. The DGF is an underutilized by-product of groundnut that has potential to be used in food system as low fat groundnut concentrate for extending comminuted meat products, production of beverages, fermented products, composite flours and protein supplementation of bakery products and weaning foods. Despite the fact that DGF has an excellent potential in food formulations because of the high protein content. (Anthony Okhonlaye Ojokoh *et al*., 2014) [3].

Fig 1: Byproduct of Groundnut

Materials and Methods
Cleaning and grading of groundnut
Groundnut were procured from local market and cleaned manually to remove all the undesirable kernels, stones, soil, bits of vines and other foreign materials. Foreign matter reduces oil and protein yields, adversely affects oil quality, and increases wear and damage to the processing equipment. After that, the groundnut pods are decorticated using a groundnut decorticator with a capacity of 100 kg /h developed at CIPHET, Ludhiana. The power requirement of the decorticator is 0.2kWh. The pods are let into the machine through a hopper where they are decorticated by beaters. The beaters had a layer of emery sheet which provide shear force. Then, the material is passed through updraft air columns via perforated grates where kernels and hulls are separated. The kernels are then passed over the various perforated grading screens where they are sorted by size into market grades. (Dowell. F.E. 1996) [4]

After decorticating the kernel is moistened and kept in tray drier at 65 °C for 3-4 h. The testa of kernel is then removed in a testa remover. After drying, kernels are packed in 5 kg pouches and stored at cool temperature. After drying, red skin was removed using testa removed.

Preparation of de-oiled peanut meal flour
For oil expelling, first the kernel is moistened with steam to attain a moisture content of 14-15% at a temperature of 80°-90 °C. The steam is generated in boiler and passed to the feeding hopper through steam outlet. Kernel is passed to the shaft with hopper whose feeding rate can be controlled. The shaft crushes and presses the seed and oil is expelled and deoiled cake is obtained at outlet. The thickness of the cake can be controlled by turning the grooves. The capacity of the oil expeller is 50kg/h and the power requirement is 0.8kWh.

Physical Properties
Geometric mean diameter and sphericity
Ten pods/ kernels were randomly selected for a sample, in order to determine the size and shape. For each, the three principal dimensions, namely length, width and thickness were measured using a venire caliper with an accuracy of 0.01 mm.

The geometric mean diameter (D_p) of the pod was calculated by using the following relationship (Mohsenin, 1970):

$$D = \sqrt[3]{LWT}$$

According to Mohsenin (1970), the degree of sphericity (ϕ) can be expressed as follows:

$$\Phi = \frac{(LWT)^{1/3}}{L} 100$$

This equation was used to calculate the sphericity of pods / kernels in the present investigation

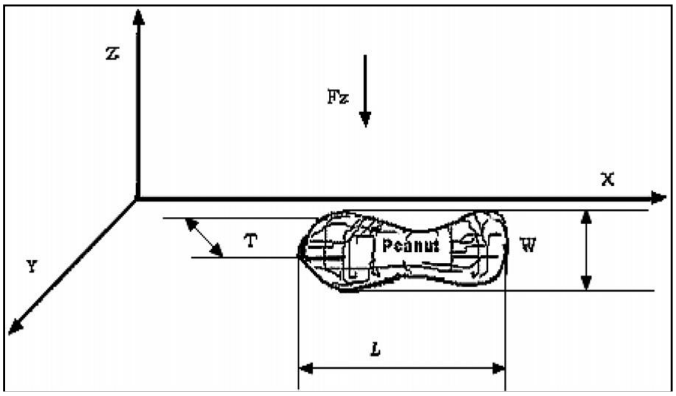

Fig 1.2: Axis and three major perpendicular dimensions of peanut

Recovery percentage
Kernel recovery percentage from the pod is 67.487%.
Kernel recovery percentage after removing testa =94.789%
Testa content of kernel = 5.21%

Bulk density
Bulk density refers to a property shared by various powders and granules as
They relate to soil attributes. It is defined as the mass of the many particles
Making up the whole divided by the total volume they occupy.

$$\rho = \frac{mass\ of\ the\ solid}{total\ volume}$$

To obtain the mass, each kernel was weighed by a chemical balance reading to an accuracy of 0.001 g.

Hardness and toughness
Texture is the property of food which is associated with the sense of feel or touch experienced by fingers or the mouth. The physical or the mechanical texture characteristics of food are related to the reaction of the food to stress and can be divided into primary parameters of hardness, cohesiveness, viscosity, elasticity, and adhesiveness, and into secondary parameters of brittleness, chewiness and gumminess. Foods are complex materials consisting of solids as well as fluid structural components which exist in a state of aggregation often referred to as semi-solid. Ferry suggested that materials having shear modulus values less than 109 dynes/cm^2 may be classified as viscoelastic foods. In practical measurement of texture, a food is subjected to compression, tension, shear and flow.

Table 1.1: Texture analyzer settings

Parameters	Settings (Hardness)	Settings (Breaking strength)
Probe	P75 mm diameter (compression platen)	HDP/ BSK (blade set with knife)
Pre test speed	3 mm/sec	5mm/sec
Test speed	1 mm/sec	2mm/sec
Post test speed	5 mm/sec	5mm/sec
Load cell	50 kg	1 nm
Distance	2mm	5mm
Trigger force	0.10 N	0.05 N

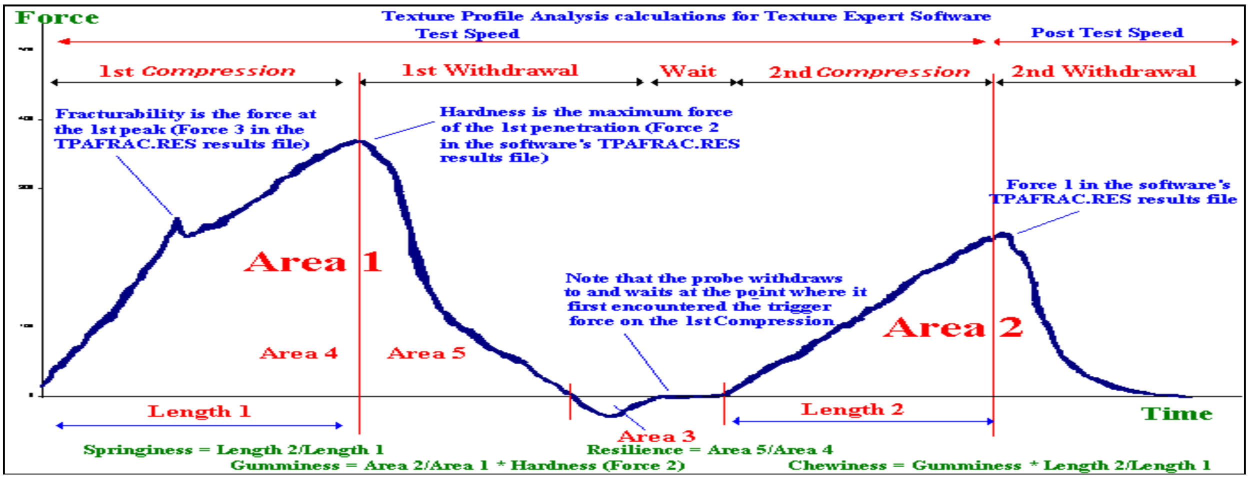

Fig 1.3: Texture Profile Analysis curve

Colour

The difference in colour of the sample (pod, kernel, and biscuits) was measured by Hunter Colorimeter (Mini Scan XE Plus, Hunter Associates Laboratory, and Reston, Virginia, USA.). At first using standard black and white tiles calibration of calorimeter was done and different samples was taken and passed one by one against port instrument by being sure that it is completely covered by the area to be measured. Four readings for each composition of sample were taken. The results were expressed as a mean value of all the samples.
L – Measures lightness (For pure white L=100 and For pure black L=00).
A – Measures redness when +ve (Measure gray when 0 and Measure greenness when –ve)
B – Measures yellowness when +ve (Measures gray when 0 and Measures blueness when –ve)
h° (Hue angle) is the characteristic of the colour by method of which the colour is recognized. C* (Chroma) is the characteristic of the colour vital to point out the quality of the colour change from grey of the similar lightness. h* and C* are measured by using the different formula.

$h^{\circ} = \tan^{-1}(b^*/a^*)$ $\quad C^* = \sqrt{a^2 + b^2}$ $\quad$ where $b = b^*$, $a = a^*$

Chemical analysis

Estimation of moisture

Moisture play an important role in food quality, preservation, and acts against the deterioration. Level of moisture must be determined to sum of the content of other food constituents on a regular basis (i.e., dry weight basis). The dry matter that remains after moisture analysis is commonly referred to as total solids. Gravimetric method is the one in which moisture content of the food material is estimated on weight basis. Moisture content of any material can be expressed in terms of wet basis and dry basis. The moisture content is usually expressed in percentage. Sometimes it is also expressed in fraction.

Crude protein

The protein content of a food product is obtained by estimating the nitrogen content of the material and multiplying the nitrogen value by 6.25 (a factor of 5.7 is used for wheat,). This is referred to as crude protein content since the non-protein nitrogen (NPN) present in the material is not taken into consideration. The true protein nitrogen can be determined by subtracting NPN from the total nitrogen. The estimation of nitrogen is done by Kjeldhal method (AOAC, 1980).

Fig 1.4: Fat extractor

Crude fat

Fat is estimated as crude ether extract of the dry material.
Solvent: Petroleum ether (40-60 ^{0}C)

Crude fat% = (Weight of fat, g/ weight of sample, g) × 100

Minerals estimation (Calcium and Iron)

Sample preparation (Ash solution)

Known amount of sample (3g) is taken in duplicate in crucibles. These are charred on a hot plate and these are placed in a muffle furnace at 600^{o} C for
ashing. After ashing and cooling the crucible to room temperature, the ash in
the crucible is dissolved in 25 ml of dilute hydrochloric acid on a water bath. The contents are transferred to a 250 ml volumetric flask and the volume is made to the mark with distilled water. The content is filtered through Whitman filter paper No. 42 and the filtrate is used for the determination of calcium, phosphorus and iron.

$$\% \text{ Ash content} = \left(\frac{W2-W1}{W}\right) \times 100$$

Where W_2-W_1= weights of silica dish along with the sample before and after drying respectively and W= weight of sample.

Results and Disscussion

Decorticator and deskinner efficiency

Whole groundnut was dehulled using a groundnut decorticator with a capacity of 100 kg /h. The power requirement of the decorticator is 0.2kWh. Decorticator efficiency was calculated around 90%. Thereafter, peanut kernels were deskinned in deskinner where red testa is removed the efficiency of the deskinner is 70 to 80%. The bulk density of the kernel is 0.530kg/m^3. It is then moistened to 14 to 15 % and heated to temperature of 70 to 80 degree centigrade and expelled through mechanical expeller and resulting cake was collected. The collected deoiled cake had 13% fat after first pass in the oil expeller about ⅔rd oil is removed. Now this cake can be further used for the baked products. Deoiled cake was analyzed for its chemical composition (Table 4.2).

Effect of deoiled groundnut cake flour level on biscuit physical properties

*A*n increase in diameter and height was observed after baking. Expansion in thickness and diameter has been tabulated in Table 4.3. The expansion in thickness was in a range of 1.047 to 2.616 while expansion in diameter ranged between 1.315 to 2.30. Maximum expansion in thickness and diameter of the biscuits on baking was found for the combination (Deoiled cake flour, pearl millet, wheat flour: 15, 90,225). However, the minimum expansion was observed for combination (Deoiled groundnut cake flour, pearl millet, wheat flour: 45, 120,225). This indicates that as the level of deoiled groundnut cake flour and pearl millet flour increased, the expansion decreases. The possible reason could be an increase in protein level in the biscuits.

Influence of deoiled groundnut cake flour level on texture of biscuits

The second important property that is considered for biscuits is hardness. The results are summarized in Table 4.3. The average peak force is the measure of biscuit hardness. Protein content of biscuits increased as the level of the deoiled cake flour increased. Wheat flour containing deoiled groundnut cake and pearl millet flours adversely affected the texture of biscuits. Biscuits made with higher levels of peanut (more than 15%) were tough and difficult to break and required higher compression force. The hardness values were ranging from 30.9 to 54.8 N, similarly cutting strength was from 22.8 to 35.7 N-mm. Hence the hardness and breaking strength gradually increased forming a harder biscuits with an increased level of peanut.

Table 1.2: Physico-chemical properties of groundnut pod and kernels

Physiochemical properties	Respective values
Bulk density	0.530 gm/cm³
Weight of hull for 100 kernel	2.9295 gm
1000 kernel weight	562.969 gm
Recovery % of kernel	67.5%
Geometric mean diameter of pod and kernel	18.644mm, 10.682mm
Sphericity of pod and kernel	52.41, 69.63
Moisture content of pod	12.8%
Moisture content of kernel	6.8%
Fat content of kernel	43 %
Protein content of kernel	21.0%
Ash content of kernel	3.8%
Hardness of kernel	53.197 N
Hardness of pod	373.13 N
L, a, b, z for kernel with testa	40.58, 17.71, 24.51, 4.96
L, a, b, z for kernel without testa	59.315, 3.31, 25.26, 14.94

Table 1.3: Physicochemical composition of the deoiled groundnut cake

Physiochemical properties	Respective values
Bulk density	0.55gm/ml
Thickness of cake	2.572mm
Moisture content	12.72%
Fat content	13%
Protein content	36%
Ash content	3.265%
Carbohydrates (%)	35.015
Calcium content	400mg/gm
Iron content	200mg/gm
W A I	135.6%
W S I	34.03%
L, A, B, YI	83.38, 1.18, 7.82, 21.84

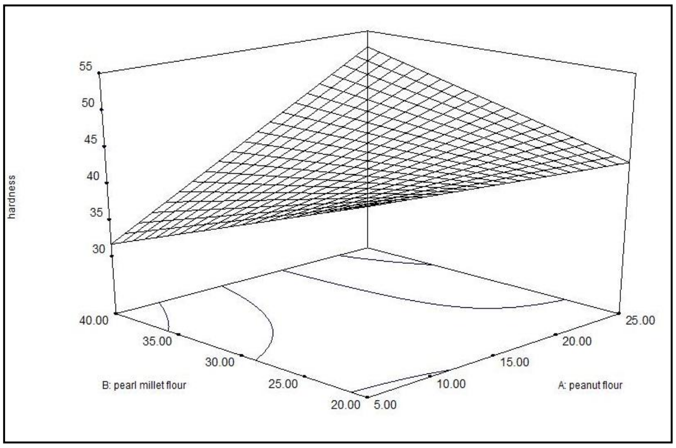

Fig 1.5: Response plot for effect of deoiled groundnut cake flour and pearl millet flour on hardness of biscuit

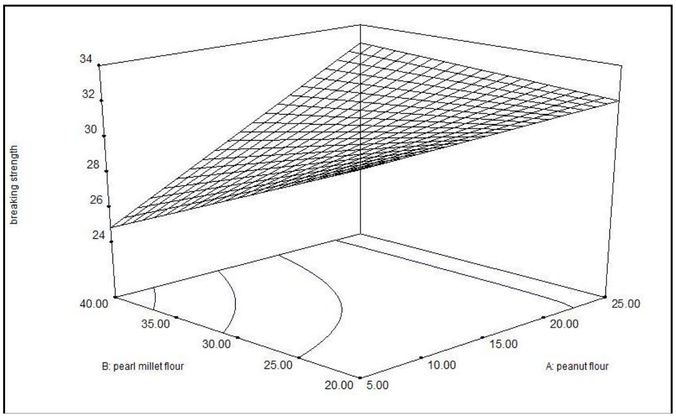

Fig 1.6 Response plot for effect of deoiled groundnut cake flour and pearl millet flour on breaking strength of biscuit

Proximate and nutritional compositions of biscuits

Proximate and nutritional composition of biscuits is summarized in Table 4.5. From the result it is evident that there was a decrease in moisture while increased for ash, crude fat and protein level. The change resulted in moisture content from 4.97 to 2.65 %, ash from 1.01 to 1.88 %, crude fat from 12.28 to 22.7 %, protein from 8.5 to12.2%. The decrease in moisture content can be contributed to the higher water binding capacity of peanut meal flour, thus lower loss. Ash, fat and protein levels are higher for peanut meal flour thus it contributed in total for biscuits also and resulted in increase with increase in peanut level. Thus it can be concluded that fortification had a positive effect on overall nutritional quality of biscuits.

Table 1.4: Color values (L, a, b) properties of biscuits

S. No	Deoiled groundnut cake flour (gm)	Pearl millet flour (gm)	Wheat flour (gm)	L	a	b
1	15	60	165	53.21	8.41	15.65
2	15	90	225	54.59	8.76	16.68
3	15	120	165	52.76	8.92	16.76
4	15	90	105	54.34	8.86	16.85
5	45	120	225	51.54	9.03	17.45
6	45	120	105	48.95	9.77	17.66
7	45	90	165	53.39	9.67	17.89
8	45	90	165	53.76	9.96	16.97
9	45	90	165	54.01	9.46	17.24
10	45	90	165	52.96	9.72	17.34
11	45	60	105	54.12	8.15	17.82
12	75	120	165	47.81	9.96	18.27
13	75	90	105	48.69	9.42	18.15
14	75	90	225	49.62	9.23	18.54
15	75	60	165	48.75	9.36	18.17

Influence of deoiled groundnut cake flour level on sensory parameters

There was not much significant difference in all the parameters even after substitution of deoiled groundnut cake flour up to 15%. For all the parameters the values were found to range from 8.0 to 7.5, which is quite an acceptable range. The typical peanut flavour and aroma was highly acceptable by the panel members. Nasir *et al*. (2008) [5] said that cookies made from de-oiled maize flour were acceptable up to 15% by the consumers. Arshad *et al.* (2007) [8], made cookies with 15% supplementation of de-oiled wheat germ flour in wheat flour showed sensory scores in the acceptable range. In all parameters there was not much difference between the control and other samples rather the texture and flavour both were acceptable by the panelist.

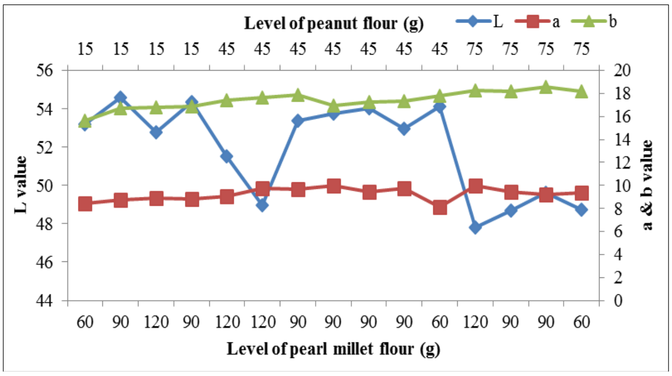

Fig 1.7: Effect of deoiled groundnut cake flour and pearl millet flour on colour values (L, a, b) of biscuit

Table 1.5: Chemical compositions of biscuit

S. No	Deoiled groundnut cake flour (gm)	Pearl millet flour (gm)	Wheat flour (gm)	Moisture Content (%)	Fat content (%)	Protein Content (%)	Ash Content (%)
1	15	60	165	4.4	14.65	8.58	1.01
2	15	90	225	4.68	12.28	8.74	1.35
3	15	120	165	4.97	14.06	8.88	1.49
4	15	90	105	4.55	13.90	8.50	1.28
5	45	120	225	3.0	18.39	9.15	1.79
6	45	120	105	3.2	19.15	8.82	1.82
7	45	90	165	3.3	18.21	9.44	1.73
8	45	90	165	3.73	18.55	9.88	1.68
9	45	90	165	3.52	18.15	9.76	1.56
10	45	90	165	3.40	18.54	9.84	1.52
11	45	60	105	3.27	19.11	9.73	1.51
12	75	120	165	2.78	20.22	10.34	1.81
13	75	90	105	2.84	22.30	11.3	1.85
14	75	90	225	2.94	22.70	12.2	1.88
15	75	60	165	2.65	22.20	10.8	1.63

Conclusion

The oil expulsion was carried out after removal of hull and testa, so the de oiled cake obtained is edible in nature with 13% fat (after first pass) and 35% protein. The de oiled cake with a higher protein percentage can be incorporated in different kind of food products to fulfill needs of undernourished population. Such incorporation will increase the utilization of de oiled peanut cake, a waste after oil extraction. As the level of de oiled peanut cake flour and pearl millet flour increased, the expansion decreased. The hardness and breaking strength gradually increased forming a harder biscuits with an increased level of de oiled peanut cake flour. Ash, fat and protein levels increased with increase in level of incorporation of de oiled peanut cake flour. Thus, it can be concluded that fortification had a positive effect on overall nutritional quality of biscuits. Biscuits with 15% supplementation of de oiled peanut cake flour showed sensory scores in the acceptable range.

Abbreviations:

DGF - Defatted groundnut flour

CIPHET - Central Institute of Post Harvest Engineering & Technology

D_p - Diameter of pod

Φ - Degree of sphericity
ρ – Bulk density
BSK - Brake Standard Corridor
HDP – Hemo dialysis product
C* - chroma
NPN - Non-protein nitrogen
AOAC - Association of Official Analytical Chemists

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