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Screening and Processing Industrial Agro Wastes for Insouble Dietary Fibers and Microcrystalline Cellulose

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ABSTRACT

The main objective of the study describes on screening of industrial agro-wastes to develop a cost effective process to produce insoluble dietary fibers as food supplements. Around 10 different types of agro wastes derived from agro processing industries that include husk, hulls, residues, pods, bran, twigs etc. It was collected across India thoroughly screened for its capability to produce dietary fibers. Nutrient profiling and fiber content was estimated for all the agro wastes of which B.G husk Native , Fried B.G husk, Soya hulls, T.D husk , U. Dhal husk were selected for fiber extraction. Among all, the Native Bengal gram husk (chick pea) was selected as best potential sources for the production of insoluble dietary fibers and microcrystalline cellulose. The study describes the process for preparation insoluble dietary fibers by simple and economic process to obtain, granular, fine granular, crystalline, Micro crystalline or amorphous types of insoluble dietary fibers from Bengal gram husk. The microscopic studies on the morphology of the treated microcrystalline cellulose was investigated illustrates the compact structure and sharp surface. An economically feasible process is demonstrated, that has a potential yields of fibers recovery to produce Insoluble dietary fibers and microcrystalline cellulose from Bengal gram husk.

Keywords: Dietary fiber, Agro-waste, Bengal gram husk, Insoluble dietary fiber, Microcrystalline cellulose.

1. INTRODUCTION

The Indian food industry is poised for huge growth, increasing its contribution to world food trade every year. India is the second largest food producer in the world. Apart from being a large food producer, India's bulk, intermediate, consumer oriented are agricultural based. Agricultural residues from agro processing industries includes husk, hulls, bran, straw, pod, leaf etc which are abundant in cellulose and lignocellulose biomass. These materials are widely used as readily available carbohydrate sources for the production of glucose, ethanol and cattle feed. Tamil Nadu is one of the largest agro processing states, agricultural residues from dhal, sugarcane, ground nut, Bengal gram, soya and rice processing facilities ranges from 10,000 to 1, 00,000 tons per annum.

In general, the first step in agro-processing industries involves dehulling or removal of unwanted portion of agro raw materials, these methods are widely applicable in legume based agro processing industries. These agro wastes can be converted into a cost effective Dietary fibres which has a wide range of application. Dietary fiber is defined as non starch polysaccharide that cannot be absorbed by humans or digested by enzymes in the human gastrointestinal tract (Trowell H, 1978). These polysaccharides include cellulose, non-cellulosic polysaccharides such as hemicellulose, pectin substances, gums, mucilage, and a non-carbohydrate component, and lignin (Dhingra D *et al.,* 2012). It is important to note that the composition of dietary fiber cannot be completely determined, and the concept of dietary fiber will likely continue to evolve (Ranikari A et al., 2016). There have been recent suggestions that the oligosaccharides known as resistance oligosaccharides should also be considered dietary fiber (Phillips G O and Cui S W, 2011),(Macagnan F T *et al.,* 2016).

In principle most of these raw materials are composed of both soluble dietary fibers (SDF) and insoluble dietary fibers (ISDF) as major integral components of the total dietary fibers (TDF). Dietary fiber can include soluble dietary fiber (SDF) and insoluble dietary fiber (IDF). SDF refers to fibers that cannot be digested or absorbed by human bodies but are partly soluble in water. Examples of SDF are some gums, such as pectin, gum Arabic, guar gum, and glucan, and also include some biological polysaccharides and synthetic polysaccharides. IDF is a fiber that cannot be digested or absorbed by human bodies and is insoluble in water. IDF includes some components of the structure of cell walls, such as cellulose, hemicellulose, and lignin. Many scholars classify dietary fiber according to the source, emphasizing that the compositions of dietary fibers extracted from different sources are different. Dietary fiber includes plant dietary fiber, synthetic dietary fiber, animal dietary fiber, and microbial dietary fiber. Current studies on dietary fiber have mainly focused on plant dietary fiber, such as dietary fiber from soybean, rice bran, corn, wheat bran, fruit, and other sources. Additional sources will be exploited gradually; for example, there is a report of spent residue from cumin as a potential source of dietary fiber (Dimitrios Trichopoulos *et al.,* 1990).

Health benefits and importance are high for both non-caloric ISDF substituted in food ingredients such as carbohydrates, proteins, fats to act as a dietary supplement and soluble dietary fiber used as dietary supplement capsule. In general, fibers slows down food flow from the stomach into the small intestine, which results in slow digestion and has been identified as a critical attribute for use as dietary supplement. Increasing consumption of dietary fiber with fruits, vegetables, whole grains, and legumes across the life cycle is a critical step in stemming the epidemic of obesity found in developed countries such as USA. The addition of functional fiber to weight-loss diets can enable rapid decrease in body mass. Epidemiology reports show that dietary fiber intake prevents obesity and fiber intake is inversely associated to saturated (trans) fat. High fibers diets have been reported to reduce risk of colon and rectal cancers, blood serum cholesterol levels and serum cholesterol. The risk of colorectal cancer in the U.S. population was reported to reduce 31% (50000 cases annually) with an average fiber intake of 13 g/day (Geoffrey R. Howe *et al.*, 1992).

Obesity is a pandemic carrying the heavy burden of multiple and serious co-morbidities including metabolic syndrome, type 2 diabetes and cardiovascular diseases. The pathophysiological processes leading to the accumulation of body fat slowly evolve to fat accumulation in other body compartments than subcutaneous tissue. This abnormal fat deposition determines insulin resistance which in turn causes blood glucose and lipid metabolism derangement, non-alcoholic fatty liver disease, hypertension, and metabolic syndrome. All these conditions contribute to increase the cardiovascular risk of obese people. Several randomized clinical trials demonstrated that moderate weight loss (5–10%) in obese patients improves obesity-related metabolic risk factors and coexisting disorders. Therefore, nutritional strategies able to facilitate weight management, and in the meantime positively influence obesity-associated cardiovascular risk factors, should be implemented. To this aim, a suitable option could be dietary fibres that may also act independently of weight loss.

Being a lot of beneficial application a dietary fibre can be added to a food product must perform in a satisfactory manner as a food ingredient (Jaime L *et al.,* 2002; Figuerola F *et al.,* 2005). From a functionality perspective, citrus fibre can play a number of roles: (i) it may be used as a tool for improving texture, (ii) as a bulking agent in reduced-sugar applications, (iii) to manage moisture in the replacement of fat, (iv) add colour, and (v) as natural antioxidant (Viuda-Martos *et al.,* 2010; Ramirez-Santiago *et al.,* 2010). Dietary fibres can provide a multitude of functional properties when they are incorporated in food systems. Thus, fibres addition contributes to the modification and improvement of the texture, sensory characteristics and shelf-life of foods due to their water binding capacity, gel-forming ability, fat mimetic, anti sticking, anti clumping, texturizing and thickening effects.

The literature contains many reports about additions of dietary fibre to food products such as baked goods, beverages, confectionery, dairy, frozen dairy, meat, pasta and soups. Most commonly, dietary fibres are incorporated into bakery products to prolong freshness, thanks to their capacity to retain water, thereby reducing economic losses. Fibres can modify bread loaf volume, its springiness, the softness of the bread crumb and the firmness of the loaf (Sangnark & Noomhorm, 2004). In addition, introduction of dietary fibre in meat products has been shown to improve cooking yield, water binding, fat binding, and texture. In the case of beverages and drinks, the addition of dietary fibre increases their viscosity and stability.

The storage, preservation, seasons remains big challenges to have adequate dietary fiber supplement or the health life, hence in the present paper we discuss about the methods of making insoluble dietary fiber with excellent shelf life and compatibility with formulations and also as a dietary supplement capsules for the maintained to the daily requirement on the dietary fibers. One of the regularly used fiber in the pharmaceutical industries includes the Crystalline and microcrystalline (MCC) as a key filler ingredients in capsule to provide adequate flow properties for direct compression, excellent binders for wet granulation. Microcrystalline cellulose [MCC] is a fine, white, odorless, crystalline powder and a biodegradable material, which can be isolated from cellulose. MCC is typically characterized by a high degree of crystallinity, although there are variations between grades; values typically range from 55 to 80% as determined by X-ray diffraction. Isolation of microcrystalline cellulose has been carried out from jute, rice husk cellulose by using the acid alkali hydrolysis [Sulfuric acid] and bleaching approach. They also reported that MCC can be used as suspension stabilizer, a water retainer in cosmetics, food and universal filler for the extrusion/spheronization process in pharmaceuticals industries The MCC is a valuable additive in pharmaceutical, food, cosmetic, and other industries. MMC obtained from different sources will differ considerably in chemical composition, structural organization, and physicochemical properties (crystalline, moisture content, surface area and porous structure, molecular weight, etc.). The high demand of microcrystalline cellulose used in pharmaceutical industries has led to the utilization of locally and naturally occurring materials in the production of microcrystalline cellulose. Many studies on the physicochemical properties of locally produced MCC derived from natural sources have been extensively evaluated in the development of a new natural source for MCC as a substitution of wood, the most abundant one.

This present paper focuses on screening several industrial agro waste for the potential of dietary fiber and microcrystalline cellulose and its properties.

2. MATERIALS AND METHODS

2.1 Sample collection

The following list of agro waste raw materials are collected from several processing industries of Tamil Nadu and listed in Table 1.

Table 1: Source and details of Agro wastes accumulated in South India

S.No	Raw material	Botanical name	Regional Name	Processing Industry
1	Baggase	*Saccharum sp*	Sugar cane	Mullamparapu Jiggery processors, Erode.
2	Bengal gram husk (Native)	*Cicer arietinum*	Garbanzo bean, Indian pea, ceci bean, bengal gram, Kabuli chana, konda kadalai, kadale kaalu, sanaga pappu, shimbra, Kadala	Asian Dhal Industries Ltd, Omalur.
3	Fried Bengal husk	*Cicer arietinum*	Garbanzo bean, Indian pea, ceci bean, bengal gram, Kabuli chana, konda kadalai, kadale kaalu, sanaga pappu, shimbra, Kadala	Asian Dhal Industries Ltd, Omalur.
4	Green pea husk	*Pisum sativum*	Pea	Asian Dhal Industries Ltd, Omalur.
5	Ground nut peel	*Arachis villosulicarpa*	Ground nut	Dhanalaxmi oil mills, Erode.
6	Rice bran	*Oryza sativa*	Rice	Modern Rice mill, Erode.
7	Soy hulls	*Glycine max*	Soy bean	Sakthi Soya Ltd, Pollachi.
8	Tapioca (Sago) fiber	*Manihot esculenta*	Tapioca, sago	Spac Tapioca products Ltd, Erode.
9	Toor dhal husk,	*Cajanus cajan*, syn. *Cajanus indicus*	Tuvari, arhar, Rohor,red gram,toovar/toor, uvaram paruppu,togari,andi,Yewof ater, gandul, guandul, guandu,Congopea,Gungo pea, Gunga pea, and no-eye pea.	Asian Dhal Industries Ltd, Omalur.
10	Urad Dhal husk	*Vigna mungo*	urad dal, udad dal, urd bean, urd, urid, black matpe bean, black gram, black lentil	Asian Dhal Industries Ltd, Omalur.

Raw material Source

Method of agriculture, food process engineering and food process methods are considered as major factors to judge the suitability of the raw materials as potential source for dietary fiber from agriculture waste for human consumptions. List of agro waste accumulate by various domestic agro processing industries are collected from various parts of Tamil Nadu. In principal all those agro wastes needs to be free from residues and chemical content to suit for human consumption. List of collected agro waste as shown in Table 1 are subjected for screening to deduct residual content of chemical fertilizer, pesticide, insecticide, sand, silicate, cyanide etc tested for the feasibility to produce food grade dietary fibers. Method of cultivation, fertilizer application varies with respect to geographical conditions and method of practice, hence there is very limited opportunity to collect or select agro wastes grown from the obvious organic cultivation methods. Careful screening and selection on residue free agro waste could enable to identify most appropriate sources of dietary fiber that can be suited for human consumption.

2.2 Screening of Agro Wastes

Bagasse is the fibrous residue remaining after sugarcane are crushed to extract their juice and is currently used as a renewable resource in the manufacture of pulp and paper products and building materials, whereas the storage of bagasse is poorly handled that enhances the proximity of the soil and silicate clogged to the substrates when kept under open environment. In case of legume based husk, the edible parts are preserved covered, protected and placed in a pod**.** The pod serves as major barrier to prevent entry of insecticide, pesticides, chemical fertilizers and any other foreign substances that could be harmful to the husk. The coating *Cicer arietinum* husk can be generated from both, native and roasted Bengal gram. Roasted gram is produced by heat treatment of Bengal gram on sand. The roasted fried gram is collected and separated from sand by holding in sack bags made out of jute for a defined period of time. Holding can result in puffing that enhances the quality of fried gram dhal. The husk known to promote healthy fibers content in humans on consumption is presently used as cattle feed to increase yield of milk therefore, by using the husk, high purity ISDF can be produced at low costs. The difference between native Bengal gram husk and Fired Bengal gram husk lies on the interaction of thermal energy that modifies the strength and property of the Husk this property is linked with the properties of the dietary fibers. In case of Rice bran the oil content is significant and separated out before processing for the dietary fiber purifications. Soybean hulls are a by-product of the process by which soybean oil and soybean meal are produced. In case of Tapioca Fiber, tapioca starch is obtained from the tuberous root of the tapioca plant and the Tapioca pulp fiber is a by-product of the tapioca starch milling operation. The unrefined tapioca fiber is typically air-dried and sold as animal feed. As a byproduct of the starch manufacturing operation, tapioca fiber may comprise the residue of the peel or outer skin, the inner rind or core, and the other fibrous components of the tuber. In de-husking process the outer cover of the raw material i.e. toor and urad is removed by passing it through several hulls.

2.3 RESIDUAL ANALYSIS OF AGRO WASTE

2.3.1 Pesticide analysis (George W & Latimer JR, 2019)

Pesticide analysis was done for agro waste residues were performed by AOAC

Official Method 2007.01. Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate.

2.3.2 Ash Content (George W & Latimer JR, 2019)

Ash content was analysed by AOAC METHOD, 2000.

2.3.3 Lignin (George W & Latimer JR, 2019)

Lignin content was determined by AOAC Official Method 973.18.

2.3.4 Tannins (George W & Latimer JR, 2019)

Tannins were estimated by AOAC Official Methods 955.25.

2.3.5 Moisture content (Umeh O N C et al., 2014)

Moisture content was estimated by Moisture analyzers (UNIBLOC). A 2.0 g sample of MCC-BV was evenly distributed over the surface of 70 mm tarred Petri dish and placed in a large desiccator (RH=100%) at room temperature. The daily weight gained by the sample over a period of 5days at various time intervals was recorded and the amount of moisture absorbed was calculated from the difference.

2.3.6 Lipid content (George W & Latimer J R, 2019)

Lipid**s** were estimated by AOAC Official Method 981.11.

2.3.7 Protein by Lowry's et al method (George W & Latimer J R, 2019)

Protein for value was analyzed Protein by Lowry's et al method with Bovine serum albumin as the standards by AOAC official method (AOAC method 2017.11.)

2.3.8 Sugars (George W & Latimer J R, 2019)

Sugars were estimated by AOAC Official Method 920.175.

2.3.9 Starch (George W & Latimer J R, 2019)

Starch were estimated by AOAC Official Method 996.11

Considering the significant content of silicate ash, and pesticide content bagasse, ground nut peel, rice bran, tapioca fiber are eliminated for further execution and not recommended for human consumptions

2.4 Separation of glycemic carbohydrate and protein

The first step of the process involves the grinding or pulverizing the crude agro-waste raw materials further subjected for the extraction of removal of the lipid content with extraction methanol-hexane (1:9) with the extraction ration 1:5, most of the polar and non polar insecticide and pesticide residues are extracted in the organic layer, further dried raw material was subjected for the removal of the glycemic carbohydrates and protein fractions. The combination of the following enzymes that includes alpha-amylase (2,00,000 u/mg-AETL), Glucoamylase (100 GOPOD/mg-Genecor), Neutral protease (1,20,000 U/mL-AETL), Flavouroazyme (1,00,000 U/g - Novozyme) , Glutanase (50,000 U/g AETL) , Papain (1100 TU/g Senthil Papain), Bromelain (2400

GDU/g Microcore) are added at 0.25% of enzyme on w/w of the raw material and reacted at 30°C for 60 minutes and further deactivated by heat treatment at 80° C for 10 minutes. The left over biomass fiber was filter pressed, washed and oven-dried at about 50°C to 60°C for 3 to 5 hrs.

2.5 Purification of insoluble dietary Fibers

The solid content of the centrifugation, after removal of the liquid content, was once again soaked in reverse osmosis in 1:7 ratios and treated with 15 % w/w food grade hydrogen peroxide in water. The mixture was cooked at 121°C for 30 minutes. The pH of the mixture turned acidic after the bleaching process, which was neutralized with the addition of 10 % NaOH. The mixture was centrifuged, pressed and air dried obtained insoluble dietary fibers product which is bright white in color with fine granular appearance at avg size of ~100 micron. The obtained insoluble dietary fibers are subjected for various specific properties.

2.6 Production of microcrystalline cellulose (Oyeniyi Y J and Itiola O A, 2012)

Production of microcrystalline cellulose (MCC) Method was adopted by **Ohwoavworhua et al., 2005** with a slight modification. A processed fibres of the α-cellulose obtained was placed in a glass container and hydrolyzed with 500 ml of 2.5N hydrochloric acid, at a boiling temperature of 105°C for 15 min. The hot acid mixture was poured into 1.5 L of cold tap water which was followed by vigorous stirring with a spatula and allowed to stand overnight. The microcrystalline cellulose obtained by this process was filtered, washed with water until neutral, filtered, pressed and dried in a hot air oven at a temperature of 60°C for 60 min in a hot air oven Following further milling and sieving, the fraction passing through 650μm sieve aperture was used for the characterization.

2.7 Physicochemical analysis of MCC

The organoleptic characteristics, identification, organic impurities and solubility were done in line with BP specifications.

2.7.1 pH: This was determined by shaking 1 g of MCC with 50 ml of distilled water for 5 min and the pH of the supernatant liquid determined using pH meter **(Oyeniyi Y J and Itiola O A, 2012)**.

2.7.2 Bulk density (DB): Five gram of MCC sample was weighed and transferred into a 50 ml dry measuring cylinder. The volume occupied by the sample was noted as the bulk volume and the bulk density determined by dividing the mass of the material by the bulk volume as expressed by **(Umeh O N C et al., 2014).**

$$\text{Bulk density} = [M / VB]$$

Where M is the mass of the sample, VB is the bulk volume of sample

2.7.3 Tapped density (DTa): The measuring cylinder containing five gram of MCC was then tapped on a wooden platform by dropping the cylinder from a height of one inch at 2 s intervals until there was no observable change in volume. The volume occupied by the material was recorded as the tapped volume **(Umeh et al., 2014)**. The tapped density was determined using the expression:

Tapped density (DTa) = [M/VT]

Where M is the mass of the sample, VT is the tapped volume of sample.

2.7.4 Microscopy

An optical electronic microscope, Nikon model Larphot2 (Nikon inc., Japan) was used for preliminary assessment of the nature of particles in MCC. A combination of both low and high power objective lens of 10x magnifications was used.

2.7.5. Total Ash Determination: 1g of sample was placed in a tarred dish, this was thereafter placed in hot oven maintained at 450°C for 3hr. the residue left after 3hr was collected and transferred into a desiccator. The weight of the residue was also noted (**Ohwoavworhua et al, 2005).**

2.7.6 Moisture Absorption profile: Two gram of the powdered sample was weighed, transferred into a Petri dish and then oven-dried for 3 h at 105°C to a constant weight. The moisture content (%) was then computed based on the initial air-dried weight **(Oyeniyi Y J and Itiola O A, 2012)**.

Moisture Content = 100 (Initial weight - Final weight/ Final weight)

3. RESULTS AND DISCUSSION

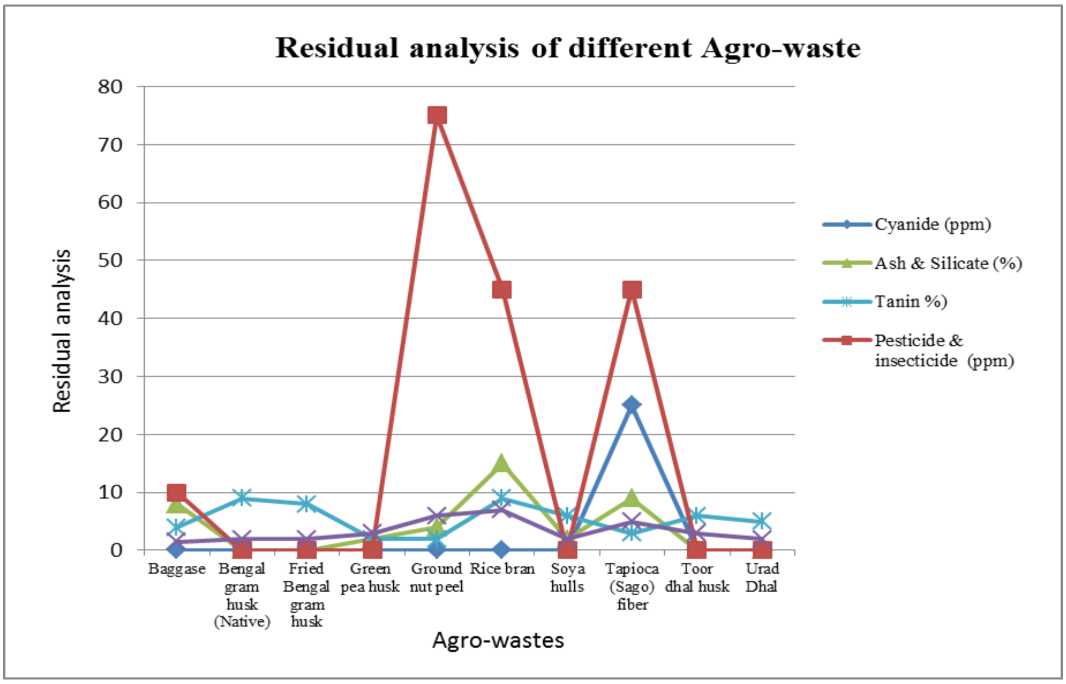
The Screening of agro wastes was performed and the residual analysis of selected agro residues was tabulated.

3.1 Residual analysis of agro waste

Residual analysis was performed for different types of agro-waste such as Baggase, Bengal gram husk (Native), Fried Bengal gram husk, Green pea husk, Ground nut peel, Rice bran, Soya hulls, Tapioca (Sago) fiber, Toor dhal husk and Urad Dhal was shown in the Table 2. From this analysis, Bengal gram husk (Native), Fried Bengal gram husk, Soya hulls, Toor dhal husk and Urad Dhal were shortlisted as the potential source. Because Bengal gram husk (Native), Fried Bengal gram husk, Soya hulls, Toor dhal husk and Urad Dhal does not contain any Pesticide & insecticide (ppm), Cyanide (ppm), Ash & Silicate (%) residues. Only Higher amount of lignin and tannin present in Bengal gram husk (Native), Fried Bengal gram husk, Soya hulls, Toor dhal husk and Urad Dhal was shown in Graph 1.

Table 2: Residual Profile of Agro wastes

S.No	Raw material	Pesticide & insecticide (ppm)	Cyanide (ppm)	Ash & Silicate (%)	Lignin (%)	Tanin %)
1	Baggase	10	-	8	1.5	4
2	Bengal gram husk (Native)	-	-	-	2	9
3	Fried Bengal gram husk	-	-	-	2	8
4	Green pea husk	-	-	2	3	2
5	Ground nut peel	75	-	4	6	2
6	Rice bran	45	-	15	7	9
7	Soya hulls	-	-	-	2	6
8	Tapioca (Sago) fiber	45	25	9	5	3
9	Toor dhal husk	-	-	-	3	6
10	Urad Dhal husk	-	-	-	2	5



Graph 1: Residual analysis of agro wastes

3.2 Nutritional profile analysis of agro waste

Nutrient profile was analysed for ten different types of agro-waste. From this result analysis, Bengal gram husk (Native), Fried Bengal gram husk, Soya hulls, Toor dhal husk and Urad Dhal has the high dietary fiber than other agro waste given in the Table 3.

Table 3: Nutrient Profile of Agro wastes

S.No	Raw material	Moisture (%)	Lipid (%)	Protein (%)	Sugars (%)	Starch (%)	DF (%)
1	Baggase	12	-	<1	5	-	45
2	Bengal gram husk (Native)	9	-	<1	-	-	70
3	Fried Bengal gram husk	6	-	<1	-	-	64
4	Green pea husk	8	-	<1	-	-	45
5	Ground nut peel	12	1	<2	-	-	48
6	Rice bran	14	13	6	2	-	51
7	Soya hulls	12	2.5	12	9	5	62
8	Tapioca (Sago) fiber	14	-	<1	3	9.5	50
9	Toor dhal husk,	12	-	<1	-	-	55
10	Urad Dhal husk	11	-	<1	-	-	53

3.3 Dietary fiber properties

Ten different types of agro-waste such as Baggase, Bengal gram husk (Native), Fried Bengal gram husk, Green pea husk, Ground nut peel, Rice bran, Soya hulls, Tapioca (Sago) fiber, Toor dhal husk and Urad Dhal was taken. From the residual and nutrient profile analysis, Bengal gram husk (Native), Fried Bengal gram husk, Soya hulls, Toor dhal husk and Urad Dhal were shortlisted as the potential source. Mess size (avg micron gram), DF content (%), ISDF content (%), ISDF BD volume (g/cc), ISDF Water absorption ratio and ISDF Lipid absorption ratio were analyzed for the shortlisted raw materials (Table 4). From the result analysis, higher percentage of insoluble dietary fiber was produced from Bengal gram (native) gram husk than other agro-waste.

Table 4: Selected Dietary fiber properties

S.No	Raw material source	Mess size (avg micron gram)	DF content (%)	ISDF content (%)	ISDF BD volume (g/cc)	ISDF Water absorption ratio	ISDF Lipid absorption ratio
1	B.G(husk Native)	Granular 150	68	99	2.5	2.85	1.45
2	Fried B.G husk	Granular 150	65	99	2.6	3.25	1.85
3	Soya hulls	Powder 90	75	35	2.00	2.56	1.5
4	T.D husk	Powder 80	55	80	1.8	2.00	1.32
5	U.Dhal husk	Powder 80	54	82	1.5	2.00	1.21

3.4 Physicochemical analysis of Microcrystalline cellulose (MCC)

Physiochemical properties of Microcrystalline cellulose (MCC) from Bengal gram husk contains Odorless, almost white, tasteless granular powder, turns violet blue with iodinated Zinc chloride, No red colour with acidified phloroglucinol, pH-6.8, 0.31 of Bulk density (g/ml), 0.33 of Tapped density (g/ml), 2.5% of total ash content, 45 % of moisture absorption profile were shown in the Table 5. Microscopy result was shown in the Figure 3-5.

Table 5: Physicochemical properties of microcrystalline cellulose

PARAMETERS	MCC
Organoleptic	Odorless, almost white, tasteless granular powder
Identification	Turns violet blue with iodinated Zinc chloride
Organic impurities	No red colour with acidified phloroglucinol
pH	6.8
Bulk density(g/ml)	0.31
Tapped density (g/ml)	0.33
Microscopy	Irregular shaped particles
Total ash content	2.5 %
Moisture absorption capacity (%)	45

Figure 1: Insoluble dietary Fiber (ISDF)

Figure 2: Microcrystalline cellulose (MCC)

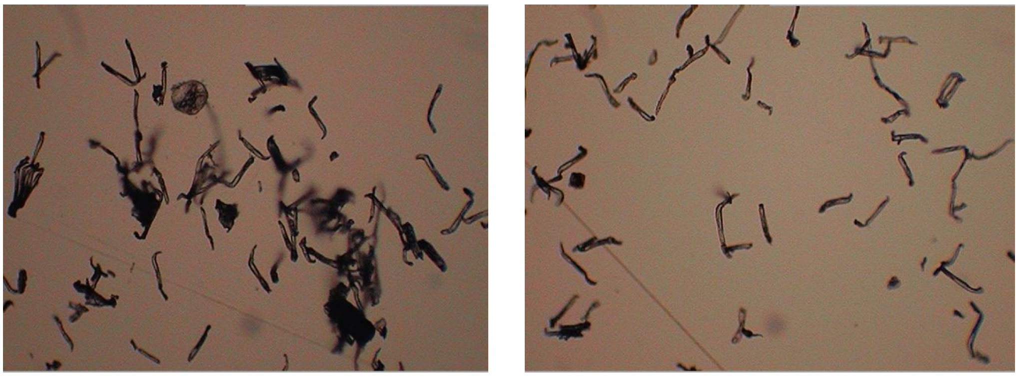


Figure 3: 10x- Magnification bright fine powdered Dietary fiber

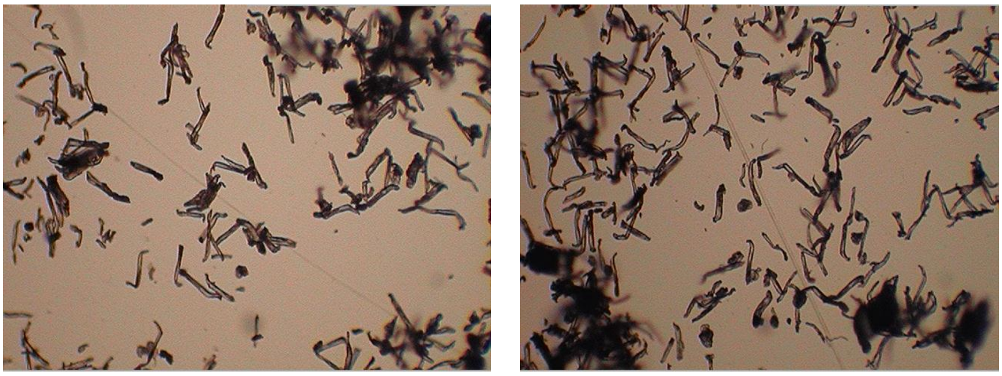


Figure 4: 10x- Magnification bright fine Granular Dietary fiber

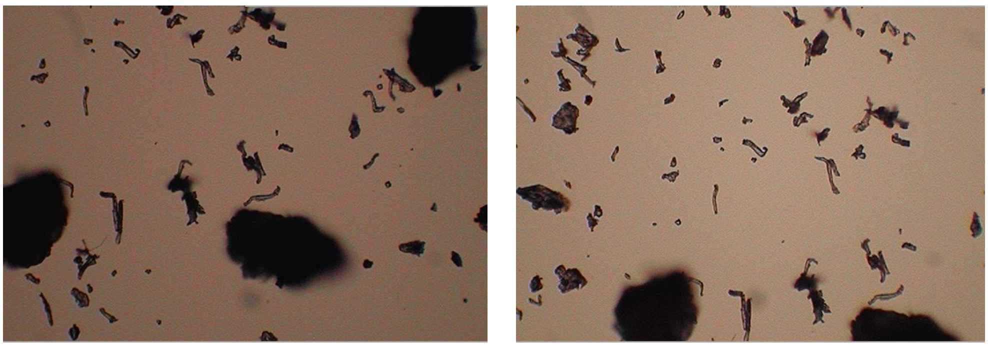


Figure 5: 10x- Magnification bright fine Micro Crystalline Cellulose Dietary fiber

4. CONCLUSIONS

Dietary fiber produced from Bengal gram, processed as per the guidance of cGMP. The product is powdered cellulose, neutral, bland, odorless used as dietary fiber, improves a vast range of food products by providing unique processing on water binding, thickening, moisture absorbing, softness promoting and anti-caking agent. Diafibe insoluble is a superior alternative by its unique functional characteristics. Neutral taste and is an excellent fat substitute that helps to reduce fat deposition. DF and ISDF content in processed Bengal gram was higher than other processed agro waste. % of DF and ISDF in processed Bengal gram was 68 and 99. Further MCC was produced from insoluble dietary fibers of Bengal gram. MCC has been shown to provide positive effects on gastrointestinal physiology, and hypolipidemic effects, influencing the expression of enzymes involved in lipid metabolism. These techno-functional and nutraceutical properties of MCC are influenced by the physicochemical of the material, which are defined by the raw material source and processing conditions. Physiochemical properties of MCC from Bengal gram husk contains Odorless, almost white, tasteless granular powder, turns violet blue with iodinated Zinc chloride, No red colour with acidified phloroglucinol, pH-6.8, 0.31 of Bulk density (g/ml), 0.33 of Tapped density (g/ml), Irregular shaped results in microscopy, 2.5% of total ash content, 45 % of moisture absorption profile. This Cost-effective production method of MCC from Bengal gram husk used as dietry food supplements.

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