EVALUATION OF NUTRITIONAL VALUE OF SEMOLINA(Triticum turgidum L. var. durum)

BY

PRECIOUS IMAOBONG ETIM

PSC1707180

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ABSTRACT

The result for proximate analysis on Semolina (Triticum turgidum L. var. durum) showed carbohydrates 76.31±0.51, crude fibre 2.43±0.10, Ash 1.86±0.43, crude fat 1.14±0.05, protein 9.14±0.22 and moisture 9.11±0.07. From the results Semolina has high carbohydrates content and the low value of moisture content indicates the longer shelf life. The results of the mineral content showed the presence of calcium 5.57±0.25, magnesium 0.94±0.27, potassium 116.57±3.96, copper 0.02±0.01, zinc 0.97±0.05 and iron 0.87±0.21 in the sample.

Semolina is rich in vitamins and minerals and other ingredients which enhance one's health. Semolina is high in fiber and protein which keeps you satisfied for a long time. It lessens one's appetite and hunger pangs which causes you to eat less and eventually loose weight. Fiber may support heart health by lowering bad cholesterol, blood pressure, and overall inflammation. Magnesium-rich diets support overall heart health. Iron helps in transporting oxygen through your blood, DNA synthesis growth and development immune system support.

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CHAPTER ONE

1.1 INTRODUCTION

1.1.1 BACKGROUND OF STUDY

Global demand for wheat is increasing due to the unique viscoelastic and adhesive properties of gluten proteins, which facilitate the production of processed foods, whose consumption is increasing as a result of the worldwide industrialization process and the westernization of the diet. Wheat is an important source of carbohydrates; globally, it is the leading source of vegetal protein in human food, having a protein content of about thirteen percent (13%), which is relatively high compared to other major cereals but relatively low in protein quality for supplying essential amino acids. When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fiber. The grain has major application in the food industry mainly bakery, followed by pasta, noodles, and other processed foods. More than two-thirds of global wheat is used for food, twenty percent (20%) is used for livestock feed and another three to five percent (3% to 5%) each for seed, industrial use and other uses just like cassava plant.

Cassava roots are subject to rapid microbial and physiological deterioration after harvest, leading to undesirable biochemical changes (Onyenwoke & Simonyan, 2014). As a result, value is added to the roots through processing to improve the palatability, increase shelf-life, facilitate transportation, as well as detoxify the roots by removing cyanogenic compounds (Westby, 2002; Nyirenda et al., 2011). In African countries in general and Nigeria, Ghana, Benin, Togo and Cote d'Ivoire, cassava roots are used in a wide range of food products such as gari, tapioca, lafun, fufu, starch and attieke. All these products differ in their functional, pasting and sensory characteristics, which are mostly influenced by the processing methods used (Sanni et al., 2003; Onitilo et al., 2007). Processing cassava roots confers a range of specific functional properties to each of the end-products. Which are determined by various biophysical processes, for instance, starch gelatinisation (Sanchez et al., 2010), degradation of cell wall components such as pectin (Eggleston and Asiedu, 1994) and formation of semolina-like particles or thick paste depending on the type of product.

Semolina is a type of coarse flour that's made from durum wheat, not from the other popular wheat type, known simply as common wheat. Semolina is obtained from cassava roots by peeling, washing, grating, pressing, fermenting (optional), sieving and roasting (Escobar et al., 2018). Hence, this seeks to examine the production of semolina and the evaluation of the nutrient value of semolina as a consumable food.

1.1.2 STATEMENT OF PROBLEM

Nearly half of all deaths in children under 5 are attributable to undernutrition; undernutrition puts children at greater risk of dying from common infections, increases the frequency and severity of such infections, and delays recovery (UNICEF, 2022). Semolina flour has several health benefits, such as; healthy muscles, improves heart health, prevents anemia, controls over eating, early bowel movement, improves immunity, boost energy, helps in weight loss. Semolina produced from durum wheat is known to have a lot of nutrient, The nutritional value of semolina consists of; Semolina, Carbohydrates, Dietary fibre ,Fat, Protein, Vitamins such as, Vitamin A ,Thiamine (B1), Riboflavin (B2),Niacin (B3), Vitamin B6, Folate (B9), Vitamin

B12, Vitamin C. Minerals such as; Calcium, Iron, Magnesium, phosphorus, potassium, sodium, zinc, and other constituent like water.

1.1.3 JUSTIFICATION OF THE STUDY

The study would be of significance to nutritionist and food manufacturers as it would enable them know the proximate analysis of semolina and its nutritional value. The study would also be of benefit to young researchers as the findings of the study properly documented would add to the body of literature review and a reference point for further research related to the study.

1.1.4 SCOPE OF RESEARCH

The study would cover the production of semolina from durum wheat bought from new benin market in Benin city, Edo state and the evaluation of the nutritional value of semolina. It will also evaluate the nutritional value of semolina; it will check via analysis whether the nutritional value and the effect it has on the quality of semolina as well as evaluate the nutritional value of semolina.

1.1.5 AIMS

The aim of this research was to evaluate the nutritional and health benefits of semolina.

The specific objectives of the study include:

- The determination of proximate analysis of semolina.
- The mineral content of semolina.

- The nutritional benefit of semolina

1.2.0 LITERATURE REVIEW

1.2.1 DURUM WHEAT

Triticum turgidum, generally known as durum wheat, is the second most widely farmed variety of wheat after bread wheat, also known as common wheat or Triticum aestivum. It is customary to plant durum wheat in the spring and harvest it in the fall. Durum wheat is well suited to the hot and dry conditions around the Mediterranean Sea (Shewry and Hey, 2015). Semolina, a form of coarse flour frequently used in pasta, especially couscous, can be made from durum wheat grains (De Santis *et al.,* 2017). They can also be processed into a finer flour and used to produce unleavened bread or pizza dough, as well as breakfast cereals, puddings, and bulgur (Kabbaj *et al.,* 2017).

Image of Durum Wheat (shutterstock)

1.2.1.1 HISTORY OF DURUM WHEAT

Durum wheat often known as pasta wheat or macaroni wheat (BSBI List 2007) (Triticum durum or Triticum turgidum subsp. durum), is a tetraploid wheat variety. (Wikipedia, 2014) Even though it only accounts for 5% to 8% of the world's wheat production, it is the second most widely farmed species of wheat after common wheat. A naked, free-threshing version of the domesticated emmer wheat strains that were once cultivated in Central Europe and the Near East circa 7000 BC was selected for artificially.(Wikipedia, 2014) Durum wheat is awned, just like emmer (with bristles). It is the main kind of wheat grown in the Middle East.

The monocotyledonous plant known as durum wheat (*Triticum turgidum ssp. durum*) is a member of the Triticeae tribe and of the Gramineae family. Durum wheat is the second-most crucial Triticum species for industrial production and human consumption, behind common wheat (*Triticum aestivum L.*).

A medium-tall annual grass known as durum has flat leaf blades and a terminal flowering spike with beautiful blooms (Bozzini, 1998). There are durum wheat variants that are semi-dwarf, similar to typical wheat varieties. The root system is made up of adventitious roots, which form subsequently from the plant's basal nodes to create the permanent root system, and seminal roots, which are formed by the immature plant during germination. The stem is cylindrical, erect, usually hollow, and subdivided into internodes. Some durum wheats have solid stems (Clarke et al., 2002).

At the main stem's basal nodes, supplemental buds give rise to culms (also known as tillers). The type of plant, the growing environment, and the planting density all affect how many culms form. A plant may generate a total of three culms in addition to the main shoot under typical field circumstances, however not all of them will certainly yield grain (Bozzini, 1988). Like other grasses, durum wheat leaves are made up of a linear terminal piece with parallel veins and an acute apex, and a basal portion (the leaf sheath) that encloses the stem. A thin, translucent membrane (ligule) with two tiny lateral appendages known as auricles is present where the leaf sheath attaches. A terminal inflorescence is produced by the main stem and each culm.

The inflorescence of durum wheat is a spike with a rachis bearing spikelets separated by short internodes (Bozzini, 1988). Each spikelet consists of two glumes (bracts) enclosing two to five florets, all borne distichously on a rachilla. Each floret is enclosed by bract like structures called the lemma and the palea. Each floret is a perfect flower, containing three stamens with bilocular anthers and a pistil bearing two styles with feathery stigmas. Mature pollen is fusiform, normally containing three nuclei. Each floret has the potential to produce a one-seeded fruit called a caryopsis. Each seed contains a large endosperm and a flattened embryo located at the apex of the seed and close to the base of the floret.

Durum wheat is best adapted to regions having a relatively dry climate, with hot days and cool nights during the growing season, typical of Mediterranean and temperate climates. Seed germination will occur as low as 2°C, but the optimal temperature is 15°C (Bozzini, 1988). Most durum wheat produced in the world is of spring growth habit; however, durum wheat lines with winter habit (requires vernalization to initiate the transition from vegetative growth to reproductive growth) have been evaluated for production in the southern USA (Domnez et al., 2000; Schilling et al., 2003).

Worldwide, the average area planted annually to durum wheat is approximately 18 million hectares, with production averaging about 30 million metric tonnes annually (International Grains Council, 2002). The European Union (mainly Italy, Spain, and Greece) is the largest durum wheat producer, averaging eight million metric tonnes yearly. Canada is the second largest producer at 4.6 million metric tonnes per year followed by Türkiye (4 million metric tonnes) and the USA (3.5 million metric tonnes) (International Grains Council, 2002).

In Canada, durum wheat production occurs in the drier, south central regions of the prairie provinces of Manitoba (2% of Canadian production), Saskatchewan (84% of Canadian production), and Alberta (14% of Canadian production).

Durum wheat is a separate species from the other commercially grown wheat classes grown in Canada (which are almost entirely *T. aestivum* L.), and possesses unique quality characteristics that differentiates durum wheat from other classes of wheat. The principal use of durum wheat grain is the production of semolina for use in pasta products. However, in North Africa, durum is preferred for the production of couscous and bulgur. Traditional breads are also made with durum flour, particularly in Morocco. Durum (derived from the Latin word for hard) has the hardest kernel of all wheats. Durum wheat with high protein content and gluten strength is the preferred choice of processors for producing pasta products. Durum kernels are amber-colored and larger than those of other wheat classes. Also unique to durum is its yellow endosperm, which gives pasta its golden color. Durum wheat with strong gluten characteristics forms strong, non-sticky dough ideal for pasta production. Semolina with strong gluten properties also results in pasta products with superior cooking characteristics. In Canada, two sub-classes of durum wheat are recognized: conventional varieties with moderate gluten strength, and extra-strong varieties with extra-strong gluten properties similar to the USA desert durum (Clarke et al., 2005).

Durum, which translates to "hard" in Latin, is the toughest variety of wheat. This alludes to the grain's resistance to milling, namely the starchy endosperm, and suggests that the dough created from its flour is fragile or "soft." Due to the additional labour required over hexaploid wheats like ordinary bread wheats, durum is better suited for making semolina and pasta than flour. Durum is not a robust wheat in the sense of imparting dough strength through the creation of a gluten network, while having a high protein content. Durum has extractable wet gluten content of 27%, which is about 3% more than normal wheat (T. aestivum L.) (Zilić *et al.,* 2011).

1.2.1.3 CLASSIFICATION /TAXONOMY OF DURUM WHEAT

Kingdom	Plantae – plantes, Planta, Vegetal, plants
Subkingdom	Viridiplantae – green plants
Infrakingdom	Streptophyta – land plants
Superdivision	Embryophyta
Division	Tracheophyta – vascular plants, tracheophytes
Subdivision	Spermatophytina – spermatophytes, seed

	plants, phanérogames
Class	Magnoliopsida
Superorder	Lilianae – monocots, monocotyledons, monocotyledons
Order	Poales
Family	Poaceae – grasses, graminées
Genus	Triticum L. – wheat
Species	Triticum durum Desf. – durum wheat

1.2.2 SEMOLINA

Semolina is a coarse flour made from durum wheat, a hard type of wheat. The word 'semolina' comes from the latin 'simila' which means flour. It is obtained from durum wheat and is believed to have originated in Central Europe and the Near East around 7000 BC (USDA, 2019). When ground into a flour, durum wheat is known as semolina and used all over the world in bread, pasta, and porridge. This flour is darker and more golden in colour than all-purpose flour. It has a mild, earthy aroma. Along with its culinary uses, semolina also benefits weight management, heart health, and your digestive system.

1.2.2.1 SEMOLINA NUTRITION

Semolina flour can be enriched, meaning that food manufacturers re-add nutrients that were lost during the processing of the durum wheat grain. Enriched semolina contains higher levels of vitamins and minerals than unenriched alternatives (IMC, 2003).

A 1/3-cup (56-gram) serving of uncooked, enriched semolina provides (Ramage *et al.,* 2014):

- **Calories:** 198 calories
- **Carbs:** 40 grams
- **Protein:** 7 grams
- **Fat:** less than 1 gram
- **Fiber:** 7% of the Reference Daily Intake (RDI)
- **Thiamine:** 41% of the RDI
- **Folate:** 36% of the RDI
- **Riboflavin:** 29% of the RDI
- **Iron:** 13% of the RDI
- **Magnesium:** 8% of the RDI

Semolina is high in protein and fiber — both of which slow digestion and increase feelings of fullness between meals (Carreiro *et al.,* 2016).It's also high in B vitamins like thiamine and folate, which have many important roles in your body, including helping convert food into energy (Kennedy, 2016).

Additionally, semolina is a good source of iron and magnesium. These minerals support red blood cell production, heart health, and blood sugar control (Rosique-Esteban *et al.,* 2018).Semolina is high in several nutrients that may support weight loss.

For starters, a 1/3 cup (56 grams) of uncooked, enriched semolina provides 7% of the RDI for fiber — a nutrient that many diets lack. Studies associate a fiber-rich diet with weight loss and lower body weight (Ramage *et al.,* 2014).

It can reduce feelings of hunger and prevent future weight gain. For example, a study in 252 women found that every 1-gram increase in dietary fiber per day resulted in weight loss of 0.5 pounds (0.25 kg) over 20 months (Tucker and Thomas, 2009).Semolina is also rich in protein, with 1/3 cup (56 grams) of uncooked semolina providing over 7 grams. Increasing protein in your diet has been shown to promote weight loss. For example, a review of 24 studies noted that a high-protein diet — compared to a standard -protein diet — resulted in 1.7 pounds (0.79 kg) greater weight loss. Increasing protein in your diet may also help reduce hunger, preserve muscle mass during weight loss, increase fat loss, and improve body composition.

1.2.2.2 BENEFITS OF SEMOLINA

- **Supports heart health**

A fiber-rich diet may reduce your risk of heart disease. A review of 31 studies found that people with the highest fiber intake may have up to a 24% reduced risk of heart disease, compared to those with the lowest fiber intake (McRae, 2017).

Fiber may support heart health by lowering LDL (bad) cholesterol, blood pressure, and overall inflammation. A small 3-week study observed that eating 23 grams of fiber per day from whole grains like semolina reduced LDL cholesterol by 5% (McRae, 2017).

Furthermore, semolina contains other heart-healthy nutrients like folate and magnesium. Diets rich in these nutrients help support heart health.

A study in over 58,000 people found that the highest intake of folate — compared to the lowest intake — was associated with a 38% reduced risk of heart disease (Cui *et al.,* 2010)).

What's more, studies indicate that magnesium-rich diets support overall heart health. For example, a study in over one million people showed that a 100 mg per day increase in dietary magnesium reduced heart failure risk by 22% and stroke risk by 7% (Rosique-Esteban *et al.,* 2018).

- **May improve blood sugar control**

Semolina may improve blood sugar control due to its high levels of magnesium and dietary fiber. Maintaining healthy blood sugar levels is an important factor in reducing your risk of type 2 diabetes and heart disease (Tuomilehto *et al., 2001*).

Magnesium may improve blood sugar control by increasing your cells' response to insulin, a hormone that regulates your blood sugar levels. In fact, magnesium-rich diets have been associated with up to a 14% reduced risk of diabetes in some studies (Takaya *et al.,* 2004)

Semolina is also rich in fiber, a nutrient essential for blood sugar control. Fiber slows the absorption of carbs into your bloodstream, helping control blood sugar spikes after a meal. It can also lower fasting blood sugar levels in people with diabetes (Silva *et al.,* 2013).

Additionally, diets rich in fiber may reduce hemoglobin A1c levels — an average blood sugar reading over a 3-month period— in people with diabetes by up to 0.5% (Silva *et al.,* 2013).

- **Rich in iron**

Iron is an essential mineral that plays many roles in your body.Some functions of iron include (Dev and Babitt,2017):

- transporting oxygen through your blood
- DNA synthesis
- growth and development
- Immune system support

Semolina is an excellent source of iron with a 1/3 cup (56 grams) of uncooked, enriched semolina providing 13% of the RDI for this nutrient (Kathryn *et al.,* 2014).

Without enough dietary iron, your body cannot produce enough red blood cells. As a result, a condition called iron-deficiency anemia may develop (Aspuru *et al.,* 2011).

Iron deficiency is the most common micronutrient deficiency worldwide. Increasing your intake of iron-rich foods may lower your risk of deficiency and subsequent anemia (Percy *et al.,* 2016).

However, semolina — like other plants — contains non-heme iron, which is not absorbed as well as the heme iron found in animal products like meat, poultry, and fish (Aspuru *et al.,* 2011).

Fortunately, adding foods rich in vitamin C like citrus fruits, berries, and tomatoes to meals with semolina can help increase the absorption of non-heme iron (Aspuru *et al.,* 2011).

1.3 PRODUCTION OF SEMOLINA

The durum wheat milling value is determined by the amount of extracted semolina with good technology properties. The procedure more widely used in the world is based on the opening of grain and the recovering, step by step, of the endosperm, going gradually from the inner to the outer part of grain. The main step include:

1. **Cleaning**

Firstly, the wheat is receptioned, analyzed and pre-cleaned. Afterwards it is classified and stored according to the following parameters: endosperm texture, vitreous appearance, protein, ash and moisture contents. The pre-cleaning process eliminates most of the larger impurities (sand, leaves, stones, wet stems, etc.), so that, the grain is best stored, and preserved. Wheat release and flow from bins and silos must be controlled to guarantee specific characteristics of mixture previously defined. This flow must also be fitted to cleaning, tempering and milling capacities. Cleaning is a very important phase whose control represents a main objective. During the cleaning process, several impurities and foreign seeds are eliminated according to the shape, dimension, density and weight. The cleaning must be effective because the dimension of semolina particles is as large as some impurities, and these could be mixed with semolina. The cleaning process is adapted to the type of wheat.

The number of cleaning machines and their positions change according to the mill and the wheat origin, depending on the kind and amount of its impurities, include the following machines: (i) Weigher and magnetic apparatus. (i) Sieving machine with aspiration channel to separate all the impurities of different dimensions from wheat. (iii) Concentrator to select a heavy fraction (70%) and a light fraction (30%) containing ergot. The heavy fraction is directed towards a destoner to remove stones in order to protect the corrugation of the rolls and to obtain perfectly cleaned semolina with low ash content; this step also avoids the damage to presses used-to produce pasta. The light fraction' is transported to a specific gravity separator which removes ergot. The healthy grains that flow from the specific gravity separator are directed to a scourer where the outer layers are cleaned and some germs are removed. The grains the pass through a cocklecylinder, a recockle cylinder and a spiral separator to recover round particles and grains.

2. Conditioning

The wheat conditioning for milling consists of two processes: damping and tempering. The water is added and has to penetrate into the grain. The goal is to modify endosperm and seed coat textures to yield large semolina and bran without endosperm, with minimal power consumption. The amount of added water and the tempering time depend on initial moisture, temperature and endosperm structure-texture. As the end moisture is16-17.5% and the initial moisture 7-8%, the water should be added in two steps, a first one to modify endosperm and a second step to prepare the seed coat before the break. The whole time of tempering is approximately 9-1 0 hours (first step 4 h, second step 5 h, third step 30 min). This type of damping and tempering gives an ideal distribution of water into durum wheat. Water addition is controlled by automatic systems; the flow of wheat is fitted by means of smaller bins. The tempering takes place when the wet grains are stored into specific bins.

3. Milling

The conventional milling should be gradual. First of all, the prepared grain passes between the corrugated rolls (breaking passage). The mixture of products of various sizes have to be sorted in the plan sifter. Afterwards, products are selected in the purifiers in several qualities according to their size. The first pure semolina can be obtained here. The purer semolina are further classified by size; the fine semolina are stored directly and the gross semolina are channeled to reduction passages, where they are reduced to regular semolina. The semolina with adherent seed coats are directed to the last breaking passages or to detach passage with corrugated rolls; this passage has the purpose of obtaining the semolina free of seed coats. Following several size and quality selections they yield purer semolina. Some diagrams have special reduction passages to transform the semolina with a lot of proportion of attached bran.

- The mechanical conditions as well as the disposition and number of machines and passages change according to the process. The break passage must work to produce minimal flours and the largest semolina to facilitate the work of purifiers. The number of break passages are six, subdivided into coarse and fine from the fourth break.

- The technical characteristics are specific to produce good semolinas (Instituto de Molineria e. Industrias Cerealistas, 1983; Abecassis, 1991): (i) main positions sharp to sharp of corrugates; some times are used to B1 and 62, the position back to back; (i) lesser diameter rolls to reduce the milling place; (iii) ratios between the speed of rolls of 1:2 to decrease the shear effect; (¡v) the sharp angles of corrugates are 25-30' and the back angles are 60-65'; (v) little load to avoid strong press on the products; (vi) the number of corrugates/cm is: in breaking passages 3.5-9.6, in detaching passages 7-10.5 and in reduction passages 8.5-9.5; (vi) the slopes of corrugates are 8-1 2% for breaking, 10-12% for detaching and 12% for reduction passages, respectively.

1.3.2 USES OF SEMOLINA

Semolina is rich in gluten; a protein that provides structure to many types of bread, pasta, and other baked goods. The tough and stretchy texture of semolina makes it one of the best types of flour to use for making pasta. You can find semolina in many grocery stores next to the all-purpose flour and specialty grains. It’s also available online. Semolina flour may go rancid if left open, so it’s best to store semolina in your refrigerator in an air-tight container.

Semolina is a flour made from ground durum wheat. It’s rich in protein, fiber, and B vitamins and may support weight loss, heart health, and digestion. Most people can enjoy semolina with no issue, but a small percentage of the population may not tolerate it due to its gluten or wheat content. If you can tolerate it, try adding semolina to your diet. Its high protein content is great for improving the structure and texture in recipes like pasta and bread.

1.3.3 CHEMICAL CONSTRAINTS FOUND IN SEMOLINA

The typical yellow-amber pigmentation is predominantly due to lipophilic carotenoids within the kernel, mainly lutein. Nonetheless, anthocyanins are also another class of pigmented phytochemicals that can be present in high amount in the grains of some wheat varieties. According to the quantity and type, this class of water-soluble pigments can give rise to wheat grains with colors ranging from red to purple (Ladhari *et al.,* 2022). In recent years, the scientific interest and appreciation of the quality of traditional wheat varieties has increased for a more sustainable low-input production of grain, as germplasm with an enhanced phytochemical profile, and as a source of adaptive traits in the face of climate change (Ladhari *et al.,* 2022). For instance, considering that wheat is a staple food in several countries, anthocyanin-rich grains can be used to produce a wide range of foods with enhanced nutraceutical and pharmaceutical properties. Old varieties are also gaining popularity to satisfy consumer demand for regional crop production and food manufacturing, to diversify the dietary basket, and to provide commercially novel products richer in health-promoting ingredients. Regrettably, the compositional properties of anthocyanin-rich grains of landraces, as well as old durum wheat varieties, have not yet been fully acknowledged, not only if compared with soft wheat varieties, but also with old species such as einkorn, emmer, and spelt (Ladhari *et al.,* 2002).

1.3.4 NUTRITIONAL VALUE OF SEMOLINA

A 1-cup (167-gram) serving of durum wheat semolina has:

- 601 calories
- 21.2 grams of protein
- 1.75 gram of fat
- 6.51 grams of dietary fiber
- 7.28 milligrams of iron
- 306 micrograms of folate

I. High in folate: That cup of semolina gives most people about three-quarters of the folate they need in a day. Folate is a B vitamin that's also known as folic acid when taken as a supplement or added to food.

II. Rich in protein. Every cell in your body contains protein. Protein is made up of amino acids. Your body makes many amino acids, but nine of them must come from the food you eat. Semolina is high in protein, without the saturated fat that meat has.

III. Rich in iron. If you've been feeling tired lately, you may be low on iron. Not having enough iron in your body is one of the causes of anemia, which is when you lack enough red blood cells. Iron is an essential part of your blood. Your body gets iron from the foods you eat. Men need 8 milligrams of iron a day, and women need 18 milligrams a day. If you're pregnant, aim for 27 milligrams a day.

IV. Rich in Vitamins: At its plant-based, durum wheat semolina has nonheme iron. Your body doesn't absorb this form of iron as well as heme iron, which is found in meat, poultry, and seafood. But you can raise the amount of nonheme iron that your body absorbs by eating semolina with foods rich in vitamin C. The ascorbic acid in vitamin C boosts iron levels.

V. Low in the glycemic index. The glycemic index is a measure of how quickly your body can digest a food and turn it into blood sugar. Some research has shown that eating foods that are lower on the glycemic index may help people with diabetes. The glycemic index of pasta made from durum wheat semolina is much lower than pasta made from regular wheat (Di Pede *et al.,* 2021).

1.4 PROXIMATE ANALYSIS

The proximate analysis is a parameter that helps us to identify thee crude protein content, the carbohydrate content, the crude fat content, ash content and moisture content of the semolina

1.4.1 DETERMINATION OF SOLUBLE CARBOHYDRATE (NITROGEN FREE EXTRACTIVE) (AOAC, 1990)

The nitrogen free extractive (N.F.E.) referred to as soluble carbohydrate is not determined directly but obtained as a difference between crude protein and the sum of ash, protein, crude fat and crude fibre.

N.F.E = 100- (% Ash + % crude fibre + % crude fat + % crude protein)

N.F.E does not refer to any particular compound or group of substances but consist of all starches and sugars, some hemicelluloses, and varying proportion of lignin. The name, soluble carbohydrate given to the fraction is therefore a misnomer.

1.4.2 DETERMINATION OF CRUDE FAT (AOAC, 1990)

The fat content in plant tissues is generally extracted with petroleum either using Soxhlet Extraction Method. In addition to fat, other substances like chlorophyll alkalies are also extracted. The volatile oils and resins are of little nutritional value.

1.4.3 CRUDE FIBRE DETERMINATION (AOAC, 1990)

The determination of crude fibre content of food and animal feed is mandatory worldwide. The loss of weight resulting from ashing corresponds to the crude fibre present in the sample. It is the residue of plant materials remaining after the solvent extraction followed by digestion with dilute acid and alkali.

1.4.4 ASH CONTENT DETERMINATION (AOAC, 1990)

Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a food sample. This laboratory exercise uses the dry ashing technique with a muffle furnace to determine the ash content of a variety of food products.

1.4.5 MOISTURE DETERMINATION (AOAC, 1990)

Moisture content influences the taste, texture, weight, appearance, and shelf life of foodstuffs. Even a slight deviation from a defined standard can adversely impact the physical properties of a food material. For example, substances which are too dry could affect the consistency of the end product. Conversely, excess moisture may cause food material to agglomerate or become trapped in the piping system during production. Also, the rate of microbial growth increases with total water content, possibly resulting in spoiled batches that need to be disposed of. However, water is also an inexpensive ingredient adding to the weight of the final product. Hence, obtaining an optimal analytical value for moisture is of great economic importance to a food manufacturer. For these reasons, food analysts engage in the delicate balancing of moisture and total solids to ensure consistent product quality, safety, and profitability.

1.4.6 DETERMINATION OF CRUDE PROTEIN (AOAC, 1990)

The estimation of crude protein involves the determination of total nitrogen usually by kjeldahl procedure. The amount of crude protein is obtained by multiplying the nitrogen content by 6.25. This factor is based on the assumption that all feed proteins contain 16% nitrogen and that all the nitrogen in the tissue is present as protein. The assumption is not generally valid. The protein content may vary in nitrogen content from 13 to 18%, the following factors are known to apply to different feeds.

Factor	Feed protein
5.4	Seed
5.9	Cereal
6.6	Leaf
6.38	Milk
6.25	Animal or Fish

6.70	Wheat

1.5 MINERAL CONTENT OF SEMOLINA

Minerals are inorganic elements that come from the soil and water and are absorbed by plants or eaten by animals. Your body requires different amounts of each mineral. People have different requirements according to the age, sex, and sometimes their state of health (pregnancy).

Potassium (186 mg), Phosphorus (136 mg) and Selenium (89.4 µg) are some of the minerals present in Semolina (freenutritionfact, 2020)

Calcium

With around 2% of an adult's body weight, calcium plays a critical role in human metabolism. There are 17 mg of calcium in 100 grams of semolina. It gives the typical adult 2% of the daily required amount.

Iron

Meats and plant meals are rich sources of iron, which is the most well-known nutritional fact concerning iron. More human health issues than any other vitamin are brought on by iron deficiency globally. 4.36 milligrams of iron, or 24% of the daily requirement for an adult, are present in 100 grams of semolina.

Potassium

Our best sources of potassium are typically vegetables, particularly those with green leaves. But practically all foods contain this mineral in variable amounts. Semolina has 186 milligrams of potassium per 100 grams, which accounts for 4% of the daily required consumption.

Magnesium

A crucial mineral in the human metabolism is magnesium. In reality, the human body uses magnesium in over 300 chemical processes. There are 47 mg of magnesium in 100 grams of semolina. It gives the typical adult 12% of the daily required amount.

Phosphorus

The second-most prevalent inorganic element in the human body is phosphorus, which is a precursor to several significant molecules like ribonucleic acid (RNA), deoxyribonucleic acid (DNA), and sugar phosphates. Phosphate serves as an energy transporter and aids in maintaining the blood's overall acid-base balance. Semolina contains 136 milligrams of phosphorus per 100 grams, which accounts for 14% of the daily required consumption.

Sodium

Muscle contractions, nerve transmissions, pH regulation, and hydration all depend on sodium. In addition to controlling the fluid inside the cells, sodium also transports waste products out of the cells, therefore it is necessary to pump fluid into the cells. One milligram of sodium, or 0% of the daily recommended amount for an adult, may be found in 100 grams of semolina.

Zinc

Many important enzymes utilize zinc as a cofactor. In actuality, there are already more than 300 identified zinc-dependent enzymes. A zinc shortage in the diet, no matter how slight, can have serious health repercussions. Semolina has a zinc content of 1.05 milligrams per 100 grams, or 7% of the adult daily required intake.

Copper

A vital mineral in numerous bodily processes is copper. It is essential for constructing dense tissue, preserving blood volume, and generating energy within your cells. Every 100 grams of semolina contains 0.18 milligrams of copper, or 9% of the daily required consumption.

Manganese

Poor bone growth is linked to a very low manganese consumption. The altered development of the protein matrix that holds minerals like calcium in place is assumed to be the cause of this condition. Semolina contains 0.61 milligrams of manganese per 100 grams, which accounts for 31% of the daily required consumption.

Selenium

We need to consume a little quantity of selenium every day, which is one of many essential dietary minerals. A tiny group of vital proteins known as "selenoproteins" contain selenium, and each of these proteins is essential to our health. 89.4 micrograms of selenium are present in 100 grams of semolina. It gives the typical adult

128% of the daily recommended value.

CHAPTER TWO

MATERIALS AND METHODS

2.1 MATERIAL

Apparatus

- Moisture can (silica dish or crucible)
- Hot air drying oven
- Desiccator
- Crucible balance
- Weighing balance
- Muffle Furnace
- Spatula
- Condenser- Soxhlet extraction unit
- Extraction boiling flask, 250-ml capacity
- Dry porous thimble
- Water bath or mantle heater
- Shaped No. 4 filter paper
- Cotton wool
- One- litre conical flask
- Poplin cloth

- Heater
- Buchner filtration unit
- Crucible or silica dish
- Spatula

Reagents

- Petroleum ether (40-60˚C boiling point)
- conc. H_2SO_4
- NaOH
- Sodium potassium tartate
- Sodium hypochlorite
- Ammonium chloride
- Sodium acetate
- Sodium phenate

2.2 METHODOLOGY

2.2.1 PROXIMATE ANALYSIS

2.2.1.1 DETERMINATION OF SOLUBLE CARBOHYDRATE (NITROGEN FREE EXTRACTIVE)

The nitrogen free extractive (N.F.E.) referred to as soluble carbohydrate is not determined directly but obtained as a difference between crude protein and the sum of ash, protein, crude fat and crude fibre.

N.F.E = 100- (% Ash + % crude fibre + % crude fat + % crude protein)

N.F.E does not refer to any particular compound or group of substances but consist of all starches and sugars, some hemicelluloses, and varying proportion of lignin. The name, soluble carbohydrate given to the fraction is therefore a misnomer.

2.2.2.2 DETERMINATION OF CRUDE FAT

The fat content in plant tissues was generally extracted with petroleum either using Soxhlet Extraction Method. In addition to fat, other substances like chlorophyll alkalies are also extracted. The volatile oils and resins are of little nutritional value.

250-ml extraction flask was dried in the oven at 105-110˚C, it was then allowed to cool in the desiccator the flask was weighed while empty, 0.5 – 2g of the sample was weighed into the labelled porous thimble, and the mouth of the thimble was covered with white cotton wool.

200ml of petroleum ether was added into the dried 250ml extraction flask, and the cover porous thimble was placed into the condenser to assemble the apparatus. Extraction went on for about 5-6 hours, then the porous thimble was removed carefully to collect the petroleum ether in the top container for re-use. The extraction flask was removed from the water bath when it is almost free of petroleum ether, the flask was then oven dried at a temperature of 105 - 110˚C it was then cooled desiccator and weight was taken after cooling

Calculation:

Weight of empty porous thimble = W0

Weight of empty thimble + ground sample = W1

Weight of ground sample = W1-W0

Weight of empty extraction flask = W2

Weight of empty extraction flask + ether = W3

Weight of ether (fat or oil) = W3-W2

$$\% \text{ Fat} = \frac{W3-W2}{W1-W0} \times 100$$

N.B: Thimble can be re-used after drying if samples are not allowed to come in contact with the actual thimble, i.e if a shaped No. 4 filter paper is used as an inter container.

2.2.2.3 CRUDE FIBRE DETERMINATION.

0.50-2.00g of the ground sample was weighed into a conical flask and 200ml of boiling 1.25% H_2SO_4 was added and boiled gently for 30 minutes cooling fingers was used to maintain a constant volume. The solution was then filtered and rinsed with hot distilled water and the residue scraped back into a flask using a spatula, 20ml of boiling 1.25% NaOH was added to the residue and was boiled gently for 30minutes, it was filtered using a poplin clothe, the residue was washed thoroughly with hot distilled water and then rinsed with 10% HCl and also rinsed twice with industrial methylated spirit (acetone or ethanol), then finally rinsed with petroleum ether (BP 40-60˚C) three times. It was then allowed to dry and then the residue was scraped into a crucible dish and allowed to dry overnight in the oven at 105˚C, afterwards it was cooled in desiccator. The sample was weighed W_1 and ashed at 550^{o}c for 90minutes in a muffle furnace, it was cooled in the desiccators and weighed again W_2.

Calculation

$$\% \text{ Crude fibre} = \frac{W1\text{-}W2}{W0} \times 100$$

2.2.2.4 ASH AND SILICA CONTENT

Ash determination

The dish was first weighed empty W_0, and then the sample was added and weighed W_1 along the dish, then it was ash in the muffle furnace at 500-600˚c for 3 hours, the sample was then allowed to cool in a desiccator. Then the weight of the dish and the sample was taken again W_2

Calculation

$$\% \text{ Ash} = \frac{W1 - W2}{W1\text{-}W0} \times 100$$

Silica Determination

The ash above was moistened with conc HCl and heated on water bath till it was dry, 30ml of 1% HCL was added and filtered using a filter paper, the residue was washed thrice with hot distilled water, the filter paper was removed carefully and folded back into the dish, it was then charred and ashed in the muffle furnace at 500-600˚c for 3 hours, the sample was cooled in a desiccator and weighed with the dish as W_3

Calculation

$$\% \text{ Silica} = \frac{W3 - W2}{W3 - W0} \times 100$$

2.2.2.5 MOISTURE DETERMINATION

The moisture can was weighed empty W_0, 2g of the semolina sample was added and weighed with the moisture can as W_1, the sample in the can was dried in hot air oven at 105-110˚c for 24 hours, cooled in a desiccator and then weighed with the dried semolina W_2 the sample was returned into the oven for another 24 hours to ensure that W_2 doesn't change

$$\% \text{ Moisture} = \frac{W1 - W2}{W1 - W0} \times 100$$

2.2.2.6 DETERMINATION OF CRUDE PROTEIN

Procedure for Digestion for Nitrogen

1mg N (25 to 50mg) sample was weighed in duplicates on a weighing balance and transferred into a digestion tube, 2ml of water was added and it was allowed to stand for about 30 minutes, a tablet of selenium catalyst was added alongside 5ml of conc. H_2SO_4, it was then heated cautiously in a fume hood until frothing stops, after digestion is clear it was still allowed to boil for about half an hour, then it was allowed to cool, then 10ml of distilled water was added slowly with swirling until undissolved materials in suspension dissolved. It was then filtered through Whatman filter paper No. 42 made up to mark 100ml volumetric flask. Filtrate is ready for colorimetric analysis.

PROCEDURE

10ml of the filtrate was pipetted into a 25ml volumetric flask and 6ml of potassium sodium nitrate, 2ml of alkaline sodium phonate solution, and 2ml of sodium hypochlorite solution were added and made up to mark with distilled water and mixed thoroughly. The solution was read on the UV/Visible spectrophotometer.

2.2.3 MINERAL CONTENT

2g of the semolina sample was weighed into a kjeldahl digestion flask and 15ml of conc HNO_3 was added, the sample was then heated with heating mantle at a temperature of 130°c for 5 hours until 2-3ml of the sample solution was remaining in the flask. After digestion, the sample solution was filtered using a Whatman 42 filter paper into a 100ml volumetric flask, washed with de-ionized water. The solution was read on the Atomic Absorbance Spectrophotometer (model 210 VGP) for calcium, magnesium, copper, zinc and iron while a flame photometer was used to determine the potassium content. All standard solutions were prepared before absorption.

CHAPTER THREE

RESULTS AND DISCUSSION

3.1 RESULTS

The following results were obtained from the proximate analysis and mineral content of semolina.

Table 3.1: Proximate analysis of semolina sample

NUTRIENTS	COMPOSITION
Moisture	9.11±0.07
Crude Protein	9.14±0.22
Crude Fat	1.14±0.05
Ash	1.86±0.43
Fibre	2.43±0.10
Carbohydrate	76.31±0.51

Data are mean and standard deviation of the triplicate determination

Table 3.2 Mineral content of semolina value

MINERALS	CONTENT
Potassium	116.56±3.96
Calcium	5.57±0.25
Magnesium	0.94+0.27
Zinc	0.97±0.06
Copper	0.02±0.01
Iron	0.87±0.21

DISCUSSION

Results from proximate analysis of semolina revealed that carbohydrate is highly present, the ash, crude fibre, crude protein, crude fat, and moisture content is comparatively low.

The content of carbohydrate is high in comparison to ash, fibre, moisture, crude protein, and crude fat are relatively low, same result was observed from research by Edith 2018.

Semolina has a long shelf life deduced from its low moisture content.

Analysis of the result in the table 3.2 for mineral content of protein revealed that the semolina produced contains calcium, magnesium, potassium, copper, zinc, and iron at a mean value of 5.57mg, 0.94mg, 116.57mg, 0.02mg, 0.97mg, and 0.87mg respectively.

CONCLUSION

Semolina is a rich source of vitamins and minerals, as well as other vital ingredients that will enhance your general health. Semolina flour in its unprocessed state has 198 calories per 60 grams. Any food that is high in fiber and protein keeps you satisfied for a long time. It significantly lessens your appetite and hunger pangs, which causes you to eat less and finally lose weight.

These advantages are also provided by semolina because to its high protein and fiber content. Additionally, even if you eat a small amount of food, the thiamine and folate in it will keep you feeling invigorated throughout the day.

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