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Nutritional and Microbial Assessment of Cookies Made from Compounded Flours

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Abstract

This study utilized composite flour from wheat, coconut shell and tiger nut to produce cookies in order to improve the nutrient contents of cookies and encourage the use of compounded flour. Appropriate quantity of the different blends of compounded flour and wheat were mixed with other ingredients to produce cookies. Microbial, organoleptic and nutritional assessments were carried out on the flour and cookies. The sensory evaluation shows the cookies produced were all acceptable in terms of texture, taste and acceptability in general. The 100% wheat flour cookies were appraised to be the best in terms of appearance and texture while 100% tiger nut flour cookies were most preferred in terms of crumbliness and general acceptability. Furthermore, 90:10 (wheat: Coconut Shell) cookies were most preferred in terms of taste. The organisms isolated were characterized and identified to be Bacillus alvei, Bacillus brevis, Saccharomyces cerevisiae, Aeromonas hydrophila and Staphylococcus aureus. Saccharomyces cerevisiae was found to be the most occurring isolate. The total viable and total fungal counts vary from 1.0 x 10^1 to 2.7 x 10^1 and 1.0 x 10^1 to 4.0 x 10^1 CFU/g respectively. Enterobacteriaceae was not detected in any of the samples. The proximate composition of the cookies were from 4.38 to 12.03, 2.10 to 20.10, 22.10 to 32.00, 3.00 to 5.00 and 1.20 to 3.10% for total crude protein, crude fibre, ether extract, moisture and total ash contents respectively. Conclusively, given the nutritional value and microbial quality of the cookies, the use of the composite flours is recommended which in return will cause a reduction in total reliance on wheat flour.

Keywords : Coco nut, Tiger nut, wheat, composite flour and flour blends

Introduction

Biscuits are nutritious snacks made from inedible dough that are changed into mouth-watering products by heating in an oven (Olaoye *et al.,* 2007). This is a common example of a ready-to-eat snack product that has several appetizing properties such as more convenient to handle because they have a longer shelf life and serve as a vehicle for important nutrients (Ajibola *et al.*, 2015). Eating western baked goods such as biscuits, breads and cakes made from wheat flour is very popular in Nigeria, particularly among children.

The flour used to make biscuits consists primarily of wheat flour or composite flour and is the basic ingredient of baked goods such as breads, buns, cakes, biscuits and other baked goods (Giwa & Ikujenlola, 2010). Also, the flour used to make many baked goods is bleached (or refined) flour, which some people believe is a “slow poison” when consumed over a long period of time due to associated health side effects (Erleen, 2011). Flour is commonly used to make biscuits along with other ingredients such as eggs, salt, margarine, flavorings, sweeteners (sugar), leavening agents and milk (Hui, 1992). They can also be fortified or enriched with other ingredients to meet specific therapeutic or nutritional needs of consumers (Ajibola *et al.*, 2015). Recently, the use of compounded flours in the bakery world has been developed for bread, cakes, biscuits and other flour-based baked products.

Composite flour is highly nutritious and very suitable for making nutritious biscuits. Composite flour can be described as a mixture of several flours derived from roots, tubers, cereals and legumes, with or without addition of wheat flour, manufactured to meet specific functional properties and nutritional composition. Biscuits are rich in fat, protein and carbohydrates. Therefore, they are sources of energy and minerals (Kure *et al.,* 1998).

Flour-based baked goods are popular foods in most parts of the world. As such, a lot of research has been done on the use of non-wheat flour with a lot of success. Moreover, improving nutrition is often another motive in the development of such materials (Okaka, 1997). Milligan et al. (1981) called compounded wheat flour a mixture of wheat flour, starch, and various ingredients, intended to replace whole or half wheat flour in bread and baked goods. It is adjudged beneficial in developing countries as it lessens imports of wheat and promotes the utilization of crops grown locally for flour (Hugo *et al.,* 2000; Hasmadi *et al.,* 2014). The expansion of the confectionery market has led to an increasing substitution of local raw materials for wheat flour (Noor & Komathi, 2009). Local raw materials used as substitutes for wheat flour include plantain skins, millet, tiger hemp nuts, pineapple skins and coconut shells. etc. Thus, the study was aimed at producing cookies by augmenting wheat flour with coconut shell and tiger nut flour and to determine their nutrition and microbial quality.

Materials and Methods

Sample Collection

The fruits (coconut and tiger nut) were purchased from Arada market in Ogbomoso, Oyo state. The wheat was purchased from Sabo market, ogbomoso, Oyo state; the margarine and sugar were purchased from Wazo market Ogbomosho, Oyo state.

Culture Media

The media used includes nutrient agar (for total viable counts); differential media (MacConkey agar and Salmonella shigella agar) for total enterobacteriacae and Salmonella shigella counts respectively; potato dextrose agar for fungal counts. These were prepared according to the manufacturers' specification and sterilized at 121°C for 15 minutes.

Processing of coconut shell flour

The coconut was purchased and the shell was separated from the endocarp by removing the shell. The coconut shells were washed with water to remove dirt and debris. The shells were left to oven dry at 105^{0}C for 24 hours. The dried coconut shell was pulverized into flour in a flour mill and sieved to obtain a fine flour sample. The flour was stored in a sterile polyethylene bag to prevent moisture absorption until cookies production.

Processing of tiger nut flour.

The tiger nut was purchased and washed so as to remove the dirt from the tiger nut samples. It was oven dried at 105^{0}C for 48 hours. The dried, clean tiger nut was milled into flour. It was subjected to further separation by sieving so as to obtain fine flour sample. The residue was disposed and the fine tiger nut flour sample was weighed and stored in a sterile polyethylene bag so as to prevent moisture absorption until cookies production.

Processing of wheat flour

Wheat seeds were examined carefully to remove all the dirt or foreign bodies from it. The wheat flour was prepared by grinding the wheat seeds in to powder. It was then stored in a polyethylene bag to prevent absorption of moisture.

Microbial evaluation of flours

One gram of each flour sample was dissolved into 9ml of sterilized peptone water and shaken thoroughly to homogenize. Ten folds' serial dilution was carried out for each sample and aliquot was drawn from appropriate dilution. It was introduced into petri dishes containing appropriate sterilized agar medium. The plates were incubated at 37ºC for 24 hours.

Formulation of blends

The coconut shell and tiger nut flour were blended into varied ratios with wheat flour to give four blends of each composite flour respectively. The ratios were (wheat flour: coconut/tiger nut flour sample) 100:0, 50:50, 70:30, 90:10 and 0:100. This was done using a measuring cup and a kitchen scale.

Preparation of cookies

Various compound mixtures prepared from the mixture of wheat and flour samples were mixed separately with equal amounts of other ingredients (margarine, sugar, milk). Measurements were carefully weighed using a kitchen scale according to various mixing ratios. Measured amounts of margarine and granulated sugar were mixed well in a rubber bowl to a smooth creamy consistency. Flour was added to the creamy mixture and kneaded until a non-sticky, plastic dough was obtained. Kneading was continued for 3 minutes to obtain a smooth plastic dough. Roll the dough into strips, cut into small pieces with a knife, press into the mold and prick lightly with a fork. Place it on a baking sheet and on the lowest temperature he baked for 15 minutes, checking occasionally, until the cookies were done. After chilling on a rack, they were wrapped with nylon packing, sealed with an impulse (nylon) sealing machine, and stored in a cool, dry place.

Organoleptic evaluation

A total number of 10 panel members were selected to evaluate the quality of the samples through sensory evaluation. The qualities assessed were appearance, taste, texture, crumbliness and general acceptance. Degree of acceptance or likeness or preference was expressed on a 5-point hedonic scale quality analysis with 1 = dislike extremely, 2 = dislike, 3 = like slightly, 4 = like and 5 = like extremely was used.

Microbial evaluation of cookies

One gram of each cookies sample was dissolved differently into 9ml of sterilized peptone water and shaken thoroughly to homogenize. Ten folds' serial dilution was carried out from each samples and aliquot was drawn from an appropriate dilution which was then introduced into petri dishes containing appropriate sterilized agar medium. The plates were incubated at 37ºC for 24 hours.

Culture examination

The incubated plates were checked after 24 hours for visible colonies after which the colonies were counted and expressed as colony forming units per gram (CFU/g).

Sub-culturing

Fresh medium was prepared and sterilized at 121°C for 15minutes and allowed to cool and poured aseptically into sterile petri dishes. The isolates inoculums were sub-cultured on the new plates by streaking in order to get distinct pure colonies. These were incubated at 37°C. After 24hours, the plates were observed for pure colony.

Culture preservation

A pure colony was picked from the plates, inoculate into a sterile nutrient agar slant, these were then incubated at 37°C for 24hours. After wards, it was preserved in the refrigerator at 4°C.

Nutritional Evaluation of the samples

Crude protein, crude fibre, ether extract, ash and moisture contents of the samples were determined using the methods of AOAC (2005) as described by Oladipo et al. (2020).

Statistical Analysis

The statistical analysis of data was done using statistical package for social sciences (SPSS) 21.1). The data were expressed as mean ± SEM and analyzed using one way Analysis of Variance (ANOVA). The difference between concentrations of the test data was determined using Duncan test and considered at p value <0.05.

Results and Discussion

The coconut shell and tiger nut were dried for two days, thereafter grinded into powder. It was observed that the tiger nut flour had a rough texture and whitish brown appearance while coconut shell flour had a smooth and deep brown appearance. The grinded wheat flour had a smooth texture and whitish appearance after milling as reported by Oladipo *et al.* (2020) (Figure1).

Figure1: Processing of tiger nut, coconut shell and Wheat Flour

Table 1 shows the microbial analysis of the wheat, coconut shell and tiger nut flour. Total viable counts are used as a measure of microbiological quality in relation to the level of the general microbial contamination. The total viable counts for the flours ranged from 1.4 x 10^2 to 3.0 x 10^2 CFU/g. Wheat flour had the highest total viable count and the tiger nut flour had the lowest. The fungal counts of coconut shell flour and tiger nut flour was 0.1 x 10^3 CFU/g, there was no fungal count for wheat flour. The result also indicated that there was no enterobacteriaceae (coliform) count for all the flour samples. The Center for Food Safety (2001) reported that bacteria are used as an indicator to reflect the sanitary quality of food. Enterobacteriaceae are used to assess the overall hygiene of food. Their detection in heat-processed foods indicates undercooking or post-processing contamination.

SAMPLE	TVC	FC	TEC
WF	3.0 X 10^2	-	-
CNSF	1.6 X 10^2	0.1 X 10^3	-
TNF	1.4 X 10^2	0.1 X 10^3	-

WF: Wheat flour, CNSF: Coconut shell flour,
TNF: Tiger nut flour, TVC: Total Viable Count,
TFC: Total Fungal Count, TEC: Total Enterobactericeae Count

Table 1: Microbial Evaluation of Coconut Shell, Tiger Nut and Wheat Flour

The sample of the cookies of various blends is shown in Figure 2. It was observed that 90:10 (wheat: tiger nut) and 70:30 (wheat: tiger nut) cookies had a slightly smooth texture, 50:50(wheat: tiger nut) and 0:100 (wheat: tiger nut) cookies had a rough texture. Coconut shell flour incorporated cookies had smooth texture and deep brownish color, 90:10 (wheat: Coconut Shell) cookies had a lighter brownish color than 0:100 (wheat: Coconut Shell), 70:30 (wheat: Coconut Shell) cookies had a light brownish color, 50:50 (wheat: Coconut shell) cookies had an almost brown color. It was noted that the higher the ratio of coconut shell flour incorporated into the cookies, the darker the color of the cookies produced. Adeoye *et al.* (2017) reported that the observed color change may be due to the heat applied during processing, which can cause a browning reaction due to the sugars in the cookies. The color of the cookies is determined by Milliard reaction between reducing sugars and proteins during baking (Chevallier *et al.,* 2000).

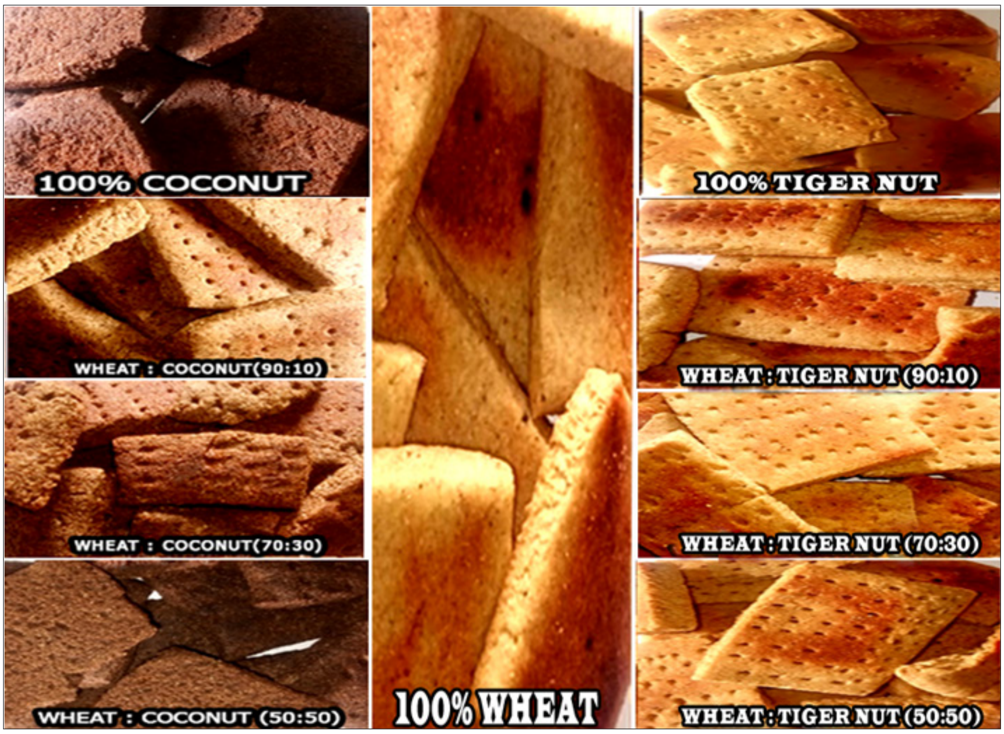

Figure 2: Cookies produced from different blends of wheat, tiger nut and coconut shell flour

The sensory evaluation of the cookies is shown in the Table 2. The appearance and texture of the cookies samples were all acceptable to the panelist. However, the 100% wheat flour cookies were most preferred in terms of appearance and texture while 100% tiger nut flour cookies were most preferred in terms of crumbliness and general acceptability. Furthermore, 90:10 (wheat: Coconut Shell) cookies were most preferred in terms of taste.

Table 3 shows the total viable and fungal counts of the cookies produced. The total viable count of all the samples vary from 1.0 x 10^1 to 2.7 x 10^1CFU/g, the 70:30 (wheat: coconut) cookies had the lowest viable count (1.0 x 10^3 CFU/g) and the 0:100 (wheat: Coconut Shell) had the highest viable count (2.7 x 10^1 CFU/g) which complies with the maximum permitted standard of 1.0×10^5 CFU/ml as highlighted in the guidelines for microbiological quality of ready to eat foods (Gilbert et al., 2000). This range is low when compared to 1.5 x 10^7 to 3.6 x10^7 CFU/g reported by Oladipo et al. (2020). The fungal count for all samples ranged from 1.0 x 10^1 to 4.0 x 10^1 but Oladipo et al. (2020) reported 0.1 x 10^7 CFU/g.

The isolated organisms were characterized and identified to be *Bacillus alvei, Bacillus brevis, Saccharomyces cerevisiae, Aeromonas hydrophila and Staphylococcus aureus.* The percentage distribution of the organisms isolated from the samples is shown in in Figure 3 and *Saccharomyces cerevisiae* had the highest percentage distribution of 33.4%. *Bacillus alvei* and *Aeromonas hydrophila* were found in 22.2% of the samples while Bacillus brevis and *Staphylococcus aureus* occurred in 11.1% of the cookies. Bacteria can also contaminate baked goods, but their growth is more limited by low water activity and low pH (Saranraj & Geetha, 2011). Ideally, it is beneficial for bakeries to only use ingredients with low levels of contamination, as raw materials are the main source of bacillus contamination (Saranraj & Geetha, 2011). Microorganisms are very important and affect our lives. They are crucial for obtaining of some foods such as yoghurt and cheese, but they are also a major contributor to the deterioration of foods and cultivar (Oladipo *et al.,* 2018). Many things contribute to the presence of microorganisms in food. Endogenous presence and cross-contamination are of primary importance (Adams & Moss, 1995). Isolated microorganisms often enter food through improper and unsanitary handling of equipment and materials used in food production, including packaging and packaging contamination (Arun, 2015).

Sensory Parameter	Appearance	Taste	Texture	Crumbliness	General Acceptability
A	7.20±0.25^{b}	6.10±0.18^{b}	6.10±0.28^{bc}	7.10±0.18^{a}	7.30±0.26^{a}
B	7.00±0.00^{b}	5.90±0.25^{bc}	5.70±0.21^{c}	6.50±0.31^{b}	6.70±0.15^{b}
C	6.30±0.25^{d}	5.70±0.26^{c}	6.50±0.34^{b}	5.90±0.10^{c}	6.70±0.29^{b}
D	6.70±0.16^{c}	6.30±0.21^{b}	5.40±0.16^{c}	7.00±0.00^{a}	6.30±0.26^{c}
E	5.90±0.18^{d}	5.40±0.16^{c}	5.70±0.15^{c}	5.80±0.13^{c}	5.80±0.13^{d}
F	6.20±0.25^{d}	6.30±0.26^{b}	6.40±0.27^{b}	5.80±0.35^{c}	6.20±0.29^{c}
G	6.10±0.10^{d}	5.80±0.13^{c}	6.20±0.29^{b}	6.00±0.00^{c}	5.90±0.27^{d}
H	5.80±0.23^{d}	6.90±0.10^{a}	5.40±0.16^{c}	5.80±0.20^{c}	5.90±0.23^{d}
I	7.50±0.15^{a}	6.70±0.15^{a}	7.00±0.00^{a}	6.40±0.34^{b}	7.20±0.29^{a}

Keys: Data represent the mean± standard error of mean (SEM). Values with the same superscript along the same column are not significantly different ($p<0.05$), A (100% tiger nut flour cookies), B (50% wheat: 50% tiger nut flour cookies), C (70% wheat: 30% tiger nut flour cookies), D (90% wheat: 10% tiger nut flour cookies), E (100% coconut shell flour cookies), F (50% wheat: 50% coconut shell flour cookies), G (70% wheat: 30% coconut shell flour cookies), H (90% wheat: 10% coconut shell flour cookies), I (100% Wheat flour cookies)

Table 2: Sensory Evaluation of the cookies from different blends of wheat, tiger nut and coconut shell flour

Sample	TVC	FC	TEC
A	2.0 X 10^{1}		
B	-	1.0 X 10^{1}	-
C	1.0 X 10^{1}	1.0 X 10^{1}	-
D	-	1.0 X 10^{1}	-
E	2.7 X 10^{1}	4.0 X 10^{1}	-
F	-	1.0 X 10^{1}	-
G	-	1.0 X 10^{1}	-
H	-	1.0 X 10^{1}	-
I	1.0 X 10^{1}	3.0 X 10^{1}	-

Key: TVC (Total Viable count), FC (Fungal count), A (100% Wheat), B (90% Wheat4: 10% Coconut), C (70% Wheat: 30% Coconut), D (50% wheat: 50% Coconut), E (0 Wheat: 100% Coconut), F (90% Wheat: 10% Tiger Nut), G (70% Wheat: 30% Tiger Nut), H (50% Wheat: 50% Tiger nut), I (0 Wheat: 100% Tiger Nut)

Table 3: Microbial Evaluation of the Cookies (CFU/g).

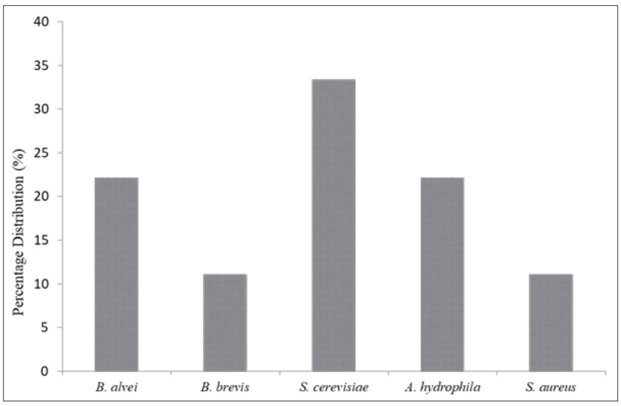

Figure 3: Percentage distribution of the organism isolated from the Cookies

The nutritional evaluation of the flour is shown in Table 4. Tiger nut flour contained 5.10% of crude protein, 4.7% crude fibre which is less compared to wheat flour that had 14.88% of crude protein and 6.50% of crude fibre. Coconut flour contained 6.5% of crude protein, 22.10% crude fibre. Wheat flour had the lowest moisture content of 8.10%, Tiger nut and coconut flour had the highest moisture content of 9.0%. Table 5 shows the nutritional evaluation of the cookies produced. It was observed that 100% wheat cookies had a high protein content of 12.03% while the cookies that contained 50:50 (wheat: tiger nut cookies) had the lowest protein content of 4.38%. The 100% coconut shell cookies had highest crude fibre content thus making coconut shell flour suitable to produce fibre rich biscuits. Dietary fibre is a group of dietary components that are resistant to hydrolysis by human digestive enzymes and is necessary for health promotion (Prakongpan *et al.*, 2006). It is popular for stimulating the digestive process, bowel movement, lower cholesterol, and positively affects blood sugar levels (Lattimer and Haub, 2010). Prevention of diabetes, obesity, coronary artery disease, colon cancer and diseases such as diverticular disease by fiber has caused growing awareness of the importance of consuming fiber-rich foods. (Rehinan *et al.,* 2004). As the demand for high-fiber foods increases, coconut shell meal may be a potential source of fiber for these products. Coconut shell meal can be used as a convenient source of dietary fiber along with related bioactive compounds. It can be incorporated as an ingredient in a variety of foods to bring significant socio-economic transformation (Arun *et al.,* 2015). It was observed that the100% tiger nut cookies had the highest ether extract values of 32.00%. Fat is an essential component of cookies and is the second largest component of soft dough cookies after flour (Okaka, 1997). Fat shortens the dough by weakening the gluten network in the dough. The result is a softer biscuit that is more fragile and has a more delicate texture. Fat also softens the texture of biscuits and prevents carbon-dioxide bubbles from escaping from the dough too quickly (Czernohorsky & Hooker, 2010). Cookies are a source of energy as they are a rich source of fat and carbohydrates (Kure *et al.,* 1998). The cookies moisture content ranges from 3.00% to 5.00% and it was observed that G (70%wheat: 30% tiger nut) cookies had the highest moisture content of 5.0%. Youssef and Mousa (2012) reported less than 6.40% moisture content of biscuits. Cookies are generally low in moisture. The biscuit's low moisture level ensures shelf stability. Moisture content of food is important for shelf life as well as packaging (Adebowale *et al.,* 2017).

In conclusion, this study shows that the composite flours could be used singly or mixed with wheat flour to produce quality cookies. The incorporation of the coconut shell and Tiger nut flour ensured that the cookies had an improved microbial and nutritive value at reduced cost. This will in turn reduce over dependence on wheat flour, increase the marketability of the cookies and boost the economy of the snacks industries.

Sample	CP (%)	CF (%)	EE (%)	Moisture (%)	Ash (%)
WF	14.88	6.50	2.00	8.10	2.00
TNF	5.10	4.70	6.00	9.00	2.00
CNSF	6.50	22.10	4.20	9.00	1.20

Key: CP (Crude Protein), CF (Crude Fibre), EE (Ether Extraction), WF (Wheat flour), CNSF (Coconut shell flour), TNF (Tiger nut Shell)

Table 4: Nutritional Evaluation of the Flour Samples

Sample	CP (%)	CF (%)	EE (%)	Moisture (%)	Ash (%)
A	12.03	2.14	22.10	4.20	3.00
B	10.50	4.50	24.20	4.20	1.20
C	7.88	4.10	24.00	4.10	3.00
D	7.10	3.50	22.20	4.10	3.10
E	6.13	20.10	22.10	3.20	3.00
F	5.63	2.10	26.20	3.40	1.60
G	5.38	2.40	26.20	5.00	2.00
H	4.38	4.20	26.10	4.00	2.00
I	7.88	2.40	32.00	3.00	2.00

Key: CP (Crude Protein), CF (Crude Fibre), EE (Ether Extraction), A (100% Wheat), B (90% Wheat: 10% Coconut), C (70% Wheat: 30% Coconut), D (50% wheat: 50% Coconut), E (0 Wheat: 100% Coconut), F (90% Wheat: 10% Tiger Nut), G (70% Wheat: 30% Tiger Nut), H (50% Wheat: 50% Tiger nut), I (0 Wheat: 100% Tiger Nut)

Table 5: Nutritional Evaluation of the Cookies

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