Journal of Postharvest Technology
2021, **09**(4): 74-83
www.jpht.in

REVIEW ARTICLE

Proximate composition of baked foods produced from various composite flour: a review

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Received: 03.09.2021 Accepted: 16.10.2021

ABSTRACT

The use of composite flour in bakery products have increased throughout the years, which aimed at reducing too much reliance on wheat flour, increasing the nutritional content of foods (micro and macro nutrients) and also preventing post-harvest loses. The proximate compositions of most bakery products have been studied in developed and developing countries, due to increase consumer knowledge on the nutritional composition of foods they eat. In this review, the proximate compositions of some popular baked foods (cookies / biscuits, bread and cakes) were reviewed, pointing out these proximate compositions: moisture, protein, fats, crude fiber, ash and carbohydrates. Their importance and methods of analysis were also highlighted with reference to several works. The proximate composition was found beneficial, enhancing the varieties of food products by the use of different composite flour and good in fighting macro and micro nutrient malnutrition.

Keywords: Baking, food, processing, nutrition, postharvest

Citation: Guyih, M. D., Bongjo, N. B., Chi, E. L., Muyong, M. G., Atam, F. M.. 2021. Proximate composition of baked foods produced from various composite flour: a review. *Journal of Postharvest Technology*, **9**(4): 74-83.

INTRODUCTION

Over the years, there have been an increase in the use of composite flours to produce baked goods; this has helped to reduce the reliance on wheat flour. Composite flour as an innovative flour has attracted much attention in research as well as food product development. Baked products have been produced from various composite flours using cereals, legumes, roots and tubers, seeds, vegetables etc. These crops include: wheat, maize, millet, almonds, cassava, soybeans, groundnuts, mango, carrots, banana, (Gbenga-Fabusiwa et al., 2018; Nyembwe et al., 2018; Emmanuel et al., 2019; Mulak et al., 2020). Composite flour can be obtained from cereals, seeds and roots for example: wheat, almond and carrot (Ahure et al., 2020), wheat and many legumes (Tufan et al., 2019), millet (Panghal et al., 2018; Wang et al., 2019) or the absence wheat flour (Adeola and Ohizua, 2018; Mohammed Nour et al.,2018) and other composite blends (Adeyeye, 2018).

Various baked products like cakes, cookies and bread have been produced from different composite flour blends. These flour blends have been proven effective in increasing the proximate composition (moisture, carbohydrates, fats, protein, ash, and fiber content) of these food products (Ifediba et al., 2015; Fahim et al., 2016; Mulak et al., 2020; Ahure et al., 2020). The need

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ISSN: 2348-4330

to improve on the nutritional needs of foods and baked products has been encouraged by organizations such as FAO, WHO, this has led to several composite flour programs which intend reduces the reliance on wheat flour as well as improve the micro and macronutrients content (proximate composition) of foods (Mulak et al., 2020). Deficiency of these macronutrients in food has led to micro and macronutrient malnutrition and has caused so many diseases such as kwashiorkor, marasmus, ricketier, scurvy (Fischer et al., 2012).

MOISTURE

Moisture content or water content is the quantity of water contained in a material. Moisture content is used in a wide range of scientific and technical areas, and it can be expressed as a ratio which can range from 0 (in completely dry materials) to the value of a materials' porosity at saturation (Sengard, 2001). The oven drying method is usually used to calculate the moisture content in a food product (AOAC, 2010). Moisture content of baked foods can influence its taste, texture, weight, appearance, and most importantly its shelf-life and keeping quality of the product. A slight change from defined or accepted ranges of standard moisture can adversely impact the physicochemical properties of a food material. For example, substances (raw materials) which are too dry could affect the consistency of the end product. Also, the rate of microbial (bacteria and molds) growth increases with total moisture content, resulting in spoilage of the food (Ahure et al., 2020). The moisture content of baked foods like bread, cake and cookies can be affected by their composite flour used. For example, the moisture content of wheat-cocoyam cookies enriched with soy flour ranged from 7.81 to 9.85 %, for wheat flour supplemented with coco-yams and soy flour. The increase in moisture content was significant; the low moisture content of a product contributes to its increase shelf life (Ojinnaka and Nnorom, 2015). A significant increase in moisture content from 9.77 to 11.83 % was also reported by (Okoye et al., 2018) on cookies from wheat, African yam bean and carrot composite flours. The moisture content of samples below 10 % was within moisture level recommended for storage stability of flours (SON, 2007). In general, the lower the moisture contents of a product, the longer the storage life. Cocoyam-Wheat Cake Enriched with Edible Palm Larvae (*Rhynchophorus phoenicis*) at substitution levels (0:100:0, 10:80:10, 20:70:10, 30:60:10, 50:40:10, 45:45:10 for Cocoyam, wheat, Palm larvae respectively) had significant moisture contents of 23.44, 23.85, 24.54, 24.78, 23.8, 23.22 respectively ((Ojinnaka and Nnorom, 2015). Higher moisture content was as a result of substitution of cocoyam and its water absorption capacity attributed to protein. This observation is in agreement with the work of Eke et al. (2018); who reported a range of moisture content from 21.1 to 23.2 % for cakes consumed in Nigeria. The carbohydrate content of the cakes decreased progressively from 50.89 % (sample 0:100:0) to 44.54 % (sample 45:45:10). Bread Made from High Quality Cassava Flour (HQCF) and Wheat Flour Blends had significant moisture content ranging from 28.50 to 34.50 % (Iwe et al., 2017). The difference in moisture may be attributed to the amount of water added during baking as cassava flour tends to absorb more water than wheat flour (Warner et al 2000). The results however are in accordance with the observation by (Nwosu et al., 2014) that bread made with cassava flour tends to retain more moisture than with wheat flour.

PROTEIN

Proteins are one of the building blocks of body tissue and also serve as a fuel source in certain situations. As a fuel, proteins provide as much energy density as carbohydrates: 4 kcal (17 kJ) per gram while lipids can provide 9 kcal (37 kJ) per gram. The most important aspect and defining characteristic of protein from a nutritional stand point is its amino acid composition (Dobermann, 2017: Agat and Dabrowska 2016). Amino acids are link together by peptide bonds to form polymeric chains of proteins. The Kjedahl method can be used to determine the protein content in a food material (AOAC, 2010). During digestion, proteins are broken down in the stomach to smaller polypeptide chains via hydrochloric acid and protease actions which is

important for the absorption of essential amino acids that cannot be biosynthesized by the body (Genton et al., 2010). The essential amino acids in the human body must obtain from their diet in order to prevent protein–energy malnutrition. The protein content of bread sample made from high quality cassava flour and wheat flour blends significantly ranged from 3.02 to 9.73 % with the wheat bread having the highest (Iwe et al., 2017). The increase in the level of substitution of cassava flour reduces the protein content of the bread sample as cassava flour does not contain gluten protein which is the protein in wheat flour responsible for dough extensibility and elasticity (Defloor, 1995; Shittu et al., 2007). The high protein content of 100 % wheat bread is an indication that wheat is a better source of protein compared to cassava, a non-protein tuber.

On the other hand, the protein content of cookies produced from wheat, almond and carrot flour increased significantly in cookies; from 6.14 % to 10.23 %.This was attributed to addition of almond flour (because of the higher protein content in almond as compared to the wheat). These results completely agree with the findings of (Baljeet et al., 2014) who reported an increase in protein content of cookies supplemented with carrot pomace powder and germinated chickpea flour. A similar trend of results was reported (Onyekwelu and Ogbu 2017: Akujobi, 2018). An increase in protein content from 6.8 to 9.3% has been reported on cakes made from soy beans and wheat flour cake (Rita et al., 2010).The increase in protein was attributed to the increase use of soy flour. A similar trend of results was reported (Banjo et al., 2006; Chinma et al., 2007; Ojinnaka et al., 2018).

FATS

In food science, fat usually refers to the ester of fatty acids, or a mixture of such compounds, fats commonly occur in living beings or in food (Kuhnt et al., 2011).The term fat often refers specifically to triglycerides (triple esters of glycerol), that are the main components of vegetable oils and of fatty tissue in animals. Fat content in food can be determined by the soxhlet extraction method making use of petroleum in extraction (AOAC, 2010). Fats are one of the three (fats, carbohydrates and protein) main macronutrient groups in human diet (Hooper et al., 2015). They are the main components of bakery margarine, milk, butter. They play certain important structural and metabolic functions in most living organisms including energy storage, water proofing, and thermal insulation. However, the human body cannot produce essential fatty acids which must be included in the diets dietary fats (Thomas, 2016). Fat content can however differ in baked foods depending on the kind of raw materials (flour) used. For example the crude fat content of bread produced from wheat flour using Avocado (Persea americana) paste as substitute ranged from 2.60 - 8.84% (Peluola et al., 2021). Sample with 50 % WF (wheat flour) and 50 % AP (avocado paste) had the highest value while sample with 100% wheat had the lowest value. There was significant difference ($p<0.05$) among the samples. Recent research on fat contents have shown that fatty fruits such as avocado and coconut have high level of fat compared to banana, orange, pawpaw and mango (Pamplona-Roger, 2007; Afolabi, 2008). The fat content in avocado fruit spread is lower than that of salad cream, peanut butter, margarine and cheddar cheese as reported by FSA (2007). The higher fat levels in samples could be attributed to the high fat content in the avocado paste which contains monounsaturated fatty acid; beneficial to the health of the bread consumers as reported by Indriyani et al. (2015).

The values obtained for the fat content of the cake made from blends of pigeon pea, sweet potato and wheat flours ranged significantly from 29.39 to 26.69 % (Olatunde et al., 2019). The general decrease in the fat contents of the products was attributed to the addition of sweet potato flour which is rich in carbohydrates. Sweet potato cultivar contains a lower level of mean crude fat content (Dakoet al., 2016). High-fat content in food can impact negatively on the shelf life of a product and stability during storage due to rancidity development. Utpal et al. (2015) reported that the addition of 5 % and 10 % mushroom powder does not affect the fat content (5.65 % and 5.81 %) compared with control (5.44 %) of mushroom (pleurotussajor-caju)

enriched biscuits. However, increasing the mushroom powder up to 15 % slightly increased the fat content (5.89 %) of biscuits. This slight elevation of fat content may be due to the fact that the original mushroom powder used in biscuits formulation contains 2.43 % fat. The fat content values of cookies baked from the blends of soya bean and maize flours ranged from 16.10 to 18.13 % (Atobatele and Afolabi, 2016). The lowest value was recorded in 100 % maize cookies (16.10 %) and was relatively high compared to the value (9.9 %) obtained by Adeyeye et al. (2014) in maize cookies supplemented with sweet potato flour.The highest value was observed in cookies samples with 30 % soy-flour substitution and was due to the high fat content of the soy-flour. The soy-flour used in this research work was not defatted and expected to add cholesterol free high-grade lipid in the cookies sample.

DIETARY FIBER

Dietary fiber or roughage is the portion of plant-derived food that cannot be completely broken down by human digestive enzymes; the method described by AOAC (2010) can be used to measure the amount of dietary fiber in a food product. They can be: soluble fiber (fermentable fiber or prebiotic fiber) which dissolves in water and is generally fermented in the colon into gases and physiologically active by-products such as short-chain fatty acids produced in the colon by gut bacteria (Keenan et al., 2016).Insoluble fiber does not dissolve in water and are inert to digestive enzymes in the upper gastrointestinal tract e.g. wheat bran, cellulose, and lignin (De Paepe et al., 2020). Coarsely ground insoluble fiber triggers the secretion of mucus in the large intestine, providing bulking movement in the gastrointestinal tract while finely ground insoluble fiber does not have this effect and can actually have a constipating effect. However, some forms of insoluble fiber can be fermented in the colon (Lockyer, 2017), examples of dietary fiber include plant components such as cellulose, resistant starch and dextrins, pectins, lignins, inulin chitins (in fungi), oligosaccharides and beta- glucans (Lockyer, 2017).

Several studies have reported different variation in the fat content of baked foods for example Baljeet et al. (2014) reported that the crude fiber content of biscuits made from carrot pomace powder and germinated chickpea flour increased significantly ($p < 0.05$) and it ranged from 0.5 to 3.2 %. The biscuits were prepared from composite flours by introducing 5, 8 and 10 parts of germinated chickpea flour and similar corresponding parts of carrot pomace powder in to wheat flour. The increase in crude fiber content was attributed to higher content of crude fiber in carrot pomace and chickpea flour than refined wheat flour. Several studies revealed similar results (Adeyeye et al. 2014; Utpal et al., 2015; Ojinnaka et al., 2018; Mulak et al., 2020). The proximate composition and quality evaluation of cocoyam-wheat cake enriched with edible palm larvae (*Rhynchophorus phoenicis*) was studied by Ojinnaka et al. (2018), with cocoyam: wheat: palm larvae ratios as follows; 0:100:0, 10:80:10 20:70:10, 30:60:10, 50:40:10, 45:45:10. The result showed that the fiber content of the cake increased as the percentage of cocoyam flour increased. Hence the composite flour blends were good sources of fiber. It has also been reported that consumption of high fiber food products enhances peristalsis, is linked to reduction in hermorrhoids, diabetes, high blood pressure, and obesity (Jaja et al., 2015).

A similar trend of result was also reported by Olatunde et al. (2019) on the nutritional and sensory properties of cake made from blends of pigeon pea, sweet potato and wheat flours. Peluola et al. (2021) researched on quality evaluation of bread produced from wheat flour using avocado (*Persea americana*) paste as substitute, avocado paste was substituted at 0, 5, 10, 15, 25 and 50 %. The crude fiber of the bread samples ranged from 0.69-1.29 %. Samples with 50:50 substitutions had the highest value while sample with no avocado paste had the lowest value. There were significant differences ($p<0.05$) among the samples except the sample 10 % and 15 % avocado paste. The crude fiber increase was as a result of increase proportion of avocado paste. The increased fiber content of the bread samples could be attributed to the high fiber content in the avocado

paste. This is an indication that the avocado fruits are good sources of fiber which could help in the digestion of food in the intestinal tract and good potential in the bakery (Boshra and Tajul, 2013).

ASH

The ash content in a food material is a measure of the total amount of minerals present within the food, while the mineral content is a measure of the amount of specific inorganic components present within a food, such as Ca, P, Mg, Fe, Zn, Cu, Na, and K. The method described by AOAC (2010) can be used to determine the ash content in a food product, where the food sample is ashed at about 600 ^{0}C in a furnace for an hour. Ash refers to the inorganic residue remaining after the water and organic matter have been removed by heating (in a furnace) in the presence of oxidizing agents, which provides a measure of the total amount of minerals within raw or cooked food (Byrneet al., 2015). The most widely used methods are based on the principle that minerals are not destroyed by heating, and that they have a low volatility compared to other food components. Three main types of analytical procedure have been used to determine the ash content in foods substances. All of these methods are based on principles: dry ashing, wet ashing and low temperature plasma dry ashing. Bakery products are usually analysed for ash by the dry ashing method (USDA, 2015).

Yusufu et al. (2018) produced bread from bambara groundnut substituted whole wheat. Blends of bambara groundnut and whole wheat flour were prepared with increasing levels of Bambara groundnut 0, 10, 20, 30 and 40 % addition in whole wheat. The blends were used in bread preparation. The ash content increased from 1.71 to 2.44 % with increase in Bambara groundnut in the blend formulation. Ash content indicates the level of mineral in a food compare with other results. Similar trend of results was reported by (Basman et al., 2003; Wachukwu et al., 2003). Adepeju et al. (2015) reported that breadfruit supplemented cookies had ash content ranging from 3.09 to 8.10 %. The breadfruit and wheat flour were mixed in the following ratios 0:100, 100:0, 20:80, 30:70, 40:60 and 50:50 respectively and were used to produce cookies. It had been observed that, breadfruit contain higher ash content than wheat as 50:50 % samples had the highest ash content 8.10 %. These results were higher than those reported by (Atobatele et al., 2016; Ayo and Gidado 2017); 1 to 1.8 % and 1.85 to 3.75 % respectively.

CARBOHYDRATES

Carbohydrates are biomolecules consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a H O atom ratio of 2:1 (as in water) and $(C_m(H_2O)_n$ where m may or may not be different from n) (Avenas, 2012). However some carbohydrates like uronic acids, deoxy-sugars do not precise this stoichiometric definition nor are all chemicals that do conform to this definition automatically classified as carbohydrates (e.g. formaldehyde) (Butryn et al., 2012).

Carbohydrates perform several roles in living organisms, for example, starch and glycogen serve for the storage of energy and also carbohydrates can form structural components like: cellulose in plants and chitin in arthropods. The 5-carbon ribose sugar (monosaccharide) is an important component of the following coenzymes ATP, FAD and NAD. Also, the backbone of the genetic molecule known as RNA, and the related deoxyribose is a component of DNA (USDA, 2015). Carbohydrates are central to nutrition and are found in a wide variety of natural and processed foods like cereals (wheat, maize, rice), potatoes, and processed foods based on cereal flour such as bread, cake, cookies etc. (Seidelmann et al., 2018).

Bread made with higher substitution level of cassava flour recorded higher carbohydrate scores compared to lower substitutions and 100 % wheat flour for Bread Made from High Quality Cassava Flour (HQCF) and Wheat Flour Blends (Iwe et

al., 2017). This is an indication that cassava tubers are good sources of carbohydrate compared to wheat and the composition produced blends with higher carbohydrate contents than the parent samples. Mulak et al. (2020) studied the quality of cookies produced from wheat almond and carrot flour blends where Wheat, almond and carrot flours were used for the production of cookies in the following ratios: 100:0:0, 90:10:0, 90:0:10, 80:15:5, 70:20:10. The results showed, the carbohydrate content decreased 81.18 % to 71.27 % in the flour blends due to the addition of almond flour, which was attributed to the low carbohydrate content in the almond and carrot flour as compared to the wheat flour. This result was similar to a reported decrease in carbohydrate content of carrot pomace powder incorporated fiber rich cookies (Prashant et al., 2017). Lucretia et al. (2017) reported a similar observation.

A decrease in carbohydrate content from 54.3, through 50.1, 44.3, 43.9, 43.9 and 43.9 % was reported by Rita et al. (2010) on the nutritional and sensory analysis of soya bean and wheat flour composite cake. Soy bean were substituted to wheat flour at the following percentages 0, 10, 20, 30, 40, and 50 % respectively. This was attributed to the fact that soy bean flour contains less carbohydrate but more protein as compared to wheat flour.An increase from 40.21 to 45.07 % carbohydrate content was reported by Olatunde et al. (2019) on the nutritional and sensory properties of cake made from blends of pigeon pea, sweet potato and wheat flours where five cake samples were produced with different ratios of wheat, pigeon pea and sweet potato in the ratio of 100:0:0, 70:20:10, 65:20:15, 60:20:20, 55:20:25. The carbohydrate increase was attributed to increase in potato flour which is a good source of carbohydrate.

CONCLUSION

Different composite flours blends have been used extensively and successfully in the production of bakery foods. The proximate composition has been one of the nutritional targets in these foods which have helped in fighting macro and micro nutrient malnutrition. Blending wheat flour with other types of flours from cereals, legumes, seeds, fungi roots and tubers etc. showed significant effect on the proximate composition of the flour blends as well as their finished products. These investigations showed that proximate composition had positive and negative effects, and it is useful for enhancing quality in the development of bakery foods. Most of the researches emphasized on the fact that the proximate composition of bakery foods is affected by the type of flour used as well as their blend ratios. Moreover, seeking ways to improve on the proximate composition of foods by using different flours has increased usefulness of different agriculture products in the future.

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