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Composite Flours for Baked Products and Possible Challenges – A Review

* Nwanekezi, E.C.[1]

ABSTRACT

This paper is a review of how consumption of bread, other leavened products and unleavened products made from wheat flour has increased rapidly in Nigeria and other developing countries. It examines how this has resulted in large scale importation of wheat and the consequent drain on the nation's foreign currency earnings. It contains some suggestions on how to reduce the high import bills of wheat by using composite flours or blends of wheatless flours in place of wheat flour for making leavened and unleavened products. Some studies on the quality characteristics of leavened and unleavened products made from composite flours or blends of wheat flours were reviewed. Some possible challenges likely to be encountered in case Nigeria changes from use of wheat flour to composite flours and blends of wheatless flours are also outlined.

Keywords: Wheat, composite, flour, products, challenges.

Introduction

Consumption of bread and other baked aerated wheat flour products has spread in Nigeria and other developing countries of the world. Wheat which is popular and unique among other cereals for making bread and other aerated baked products can only grow in very few developing countries. The exceptions are where there is a temperate zone caused by high latitude or high altitude or both (examples are Mexico, Northern India, Eastern Africa) (Dendy, 2001). Nigeria cannot grow wheat in large quantities. Wheat is imported from temperate countries that have surplus. Due to urbanization and rapid population growth, wheat imports to Nigeria have grown rapidly. According to United States Department of Agriculture, Nigeria imported 4.1 million metric tonnes of wheat in 2011. These imports are paid for with scarce foreign currency. And this, no doubt, is depleting Nigeria's external currency earnings and reserve.

In the bid to lower or stop outrightly imports of wheat, the Nigerian government and Food and Agriculture Organization (FAO) have encouraged the use of composite flours and blends of wheatless flours or meals for the production of aerated products such as bread, biscuit, cake, doughnut, etc.

Fortunately, Nigeria has large fertile arable lands where food crops are grown. Cassava, maize, rice, millet and sorghum are grown in large quantity in Nigeria. Nigeria is the world's largest producer of cassava (FAO, 2006). Flours from this and other food crops are often blended with wheat flour to form composite flours. Quality characteristics of aerated and non-aerated products made from composite flours and blends of wheatless flours have been studied and published in some scientific journals. There are however some challenges

[1] Department of Food Science and Technology, Imo State University, Owerri, Imo State.
* corresponding author: profecnwanekezi@gmail.com.

militating against industrial uses of composite flours and blends of wheatless flours or meals. This write-up therefore reviews the use of composite flours in the production of leavened and unleavened products and highlights the possible challenges militating against their use.

Bread – A universal food

Bread, biscuit, cake, doughnut, noodles and other wheat flour based products are popular in Nigeria and indeed all parts of the world. Bread is the most popular among all the wheat-based products. Wheat flour bread celebrates the richest and simplest pleasures of daily living. In most European cultures, it is the single inevitable presence at the table during all the three meals of the day (Kent, 2000). In Nigeria, it is consumed by people in every socio-economic class and it is acceptable to both children and adults. Bread has gained wide consumer acceptance for many years in Nigeria (Badifu *et al.*, 2005; Abulude, 2005). There is no household or family in Nigeria that does not consume at least one wheat-based product a day.

Uniqueness of wheat for bread making

Cereal grains have similar percentage proximate compositions but only wheat flour dough is capable of retaining gas during proof and baking and therefore forms a typical aerated foam structure that we know as bread. The uniqueness of wheat flour for making aerated baked products is largely due to its gluten protein. Although other cereals contain similar protein groups to gluten, their gas-holding capacity is limited (Dobraszcyk, 2001). Although all leavened cereal doughs produce gas (carbon dioxide) during proof, wheat dough retain gas much longer and up to higher temperature (72°C) than other cercal flour doughs (He and Hoseney, 1991). The carbon dioxide of other cereal doughs is released much earlier during proof. Wheat gluten is made up of a mixture of two groups of proteins: gliadins and glutenins, which make different contributions to the viscoelasticity of gluten. The gliadins are viscous and extensible but lack elasticity. Glutenins lack extensibility but exhibit substantial strength and elasticity. While gliadin cannot retain gas, due to its extensibility, glutenin can retain gas but the gas cannot expand or grow due to its strength (elasticity). Thus, it is the combination of the two groups of proteins (gliadins and glutenins) that imparts the unique viscoelastic properties responsible for gas retention in wheat flour.

Wheat imports and impact on foreign currency earning

Due to increasing population, urbanization and changing food habits, the consumption of leavened and unleavened wheat flour products has increased tremendously in developing countries in recent years (Eggleston *et al.*, 1992). Bread and other baked products are however relatively expensive, as they are produced from wheat which, as a result of climatic reasons, does not grow well in the tropics and has to be imported (Ederma *et al.*, 2004). Wheat is mostly cultivated in all parts of the world, most especially in North America, South America (Argentina), Europe, Australia and India. Wheat cultivation is scarcely carried out in the tropics and it does not do well. Though wheat cultivation in Nigeria dates back to the 16th century, it is grown only in the Sahel and Sudan Savannah zones (Olugbemi *et al.*, 1992). Only about three per cent of Nigerian's total consumption of this grain is produced locally (Agu *et al.*, 2007). As a result, 97% of wheat used for producing wheat-based products are imported. Nigeria imported a total of 4,100,000 metric tonnes of wheat in the year 2011 according to United State Department of Agriculture.

The Honourable Minister of Agriculture and National Resources, Chief Akinwumi Adesina in the weekly post Federal Executive Council meeting media briefing to the press in 2011 stated that Nigeria spends a whopping sum of 635 billion Naira annually on wheat importation (Adesina, 2011). The amount of money spent on wheat importation annually constitutes a very big drain in Nigeria's foreign exchange earnings and reserve.

Possible ways of cutting high wheat import bill

In countries that grow staples other than wheat, it is considered economically advantageous to reduce or even eliminate imports of wheat and the demand for bakery products met by use of locally grown raw material (Mepba *et al.*, 2006). Efforts have been made in many countries to produce bread by conventional methods from wheat flour to which other flours such as cassava flour are added. The Nigerian government has created awareness in recent years in the use of composite flours, especially cassava flour. The FAO composite flour programme of 1964 encourages developing countries to save foreign exchange on wheat importation by replacing part of it with local products in bread baking (Onabola *et al.*, 2003). Nigeria found cassava flour best in bread baking (FAO, 2006). Nigerian government has directed the flour (wheat) millers to incorporate 10% cassava flour in the flours they produce. The deadline for the incorporation of 10% cassava flour into wheat flour was slated for July 2006 but it was on February 2, 2007 that government mustered the political will to shut down some defaulting mills (Sonowo, 2007*). And this was abandoned by flour millers as soon as President Olusegun Obasanjo left office in 2007. The Federal Government has decided to encourage the injection of about 50% of cassava based flour into the bread market. This according to the Honourable Minister of Agriculture and Natural Resources, Chief Akinwumi Adesina, could save up to half the cost of wheat import which is about 315 billion Naira (Adesina, 2011). Fortunately, Nigeria is now the world's largest producer of cassava, having overtaken Brazil and Thailand (FAO, 2006). Cassava production in 2011 was estimated as high as 45 million tonnes (Ellul *et al.*, 2011).

Locally grown crops and high protein seeds have been used as replacement for wheat in baked products. Although wheat is an indispensable ingredient in leavened bakery products, flours and meals from many other grains are frequently used as ingredients for the purposes of enhancing flavours or colour, reducing ingredient cost, meeting requirements for certain ethnic markets, improving nutritional aspect and distinguishing one commercial item from a multitude of similar products (Samuel, 1992).

Some studies on the use of composite flours and blends of wheatless flours (1994 – 2010)

1. Bread

(i) Wheat – fluted pumpkin seed composite flour bread was produced by Agu *et al.* (2010). Wheat

Table 1: Effect of fluted pumpkin seed flour on the sensory properties of bread

	WF-FPSF Ratio	Taste	Colour	Sensory Texture	Scores Flavour	General Acceptability
Comparable ↑	100:0	7.60^{a}	8.10^{a}	7.95^{a}	7.40^{a}	7.90^{a}
	90:10	7.55^{ab}	7.45^{ab}	7.85^{a}	7.30^{a}	7.70^{ab}
	80:20	6.60^{abc}	7.35^{ab}	7.35^{ab}	6.55^{ab}	7.30^{abc}
	70:30	6.05c	5.85c	5.90c	6.00^{b}	6.30c
Inferior ↓	60:40	6.50^{bc}	6.75^{bc}	6.35^{bc}	6.00^{b}	6.60^{bc}
	50:50	7.60^{c}	6.15^{c}	6.60^{bc}	6.60^{ab}	6.80^{bc}
	LSD	1.07	0.99	0.99	0.95	0.91

WF = Wheat flour; FPSF = fluted pumpkin seeds flour
Means with different superscripts on the column are significantly different ($P < 0.05$). Values are means of scores of 20 panelists.

Source: Agu *et al.* (2010)

* Punch Newspaper, Monday Feb. 5, 2007, p. 8.

flour was replaced at 10%, 20%, 30%, 40% and 50% levels with fluted pumpkin seed flour. Replacement above 20% affected the loaves texture as they became hard due to low specific volume. In sensory evaluation scores loaves baked with 10% and 20% fluted pumpkin flours were similar to 100% wheat flour bread.

(ii) Wheat-cocoyam composite flour bread

Flours from two cultivars of *Colocasia esculenta* (A = ede ofe, B = cocoindia) and *Xanthosoma sagitfolium* (ede uhie) were used as substitutes to wheat flour at 10, 20 and 30% levels for bread production by Idowu *et al.* (1996). Oven springs and specific volumes were found to decrease with increasing ratios of cocoyam flour in the wheat-cocoyam composite breads. Wheat-*Colocasia* A composite flour breads had the highest oven spring and specific volume compared to other wheat-cocoyam cultivars flours breads. Wheat-*Colocasia* B composite flour bread had the lowest oven spring and specific volume.

Table 2: Quality of Wheat-cocoyam composite flour bread

WF- CF ratio	Oven spring (ml)	Specific Vo. (ml/g)	Overall sensory acceptance (100)
100:0	2.3	5.3	86.3[a]
Colocasia A			
90:10	1.8	5.3	81.1[a]
80:20	1.3	4.4	70.8[b]
70:30	0.9	4.3	63.7[c]
Colocasia B			
90:10	1.3	4.5	75.7[b]
80:20	0.7	2.8	61.3[c]
70:30	0.5	2.3	50.5[d]
Xanthosoma			
90:10	1.7	4.7	75.8[b]
80:20	1.2	4.0	67.4[cb]
70:30	0.7	3.5	56.6[d]

WF = Wheat flour; CF = cocoyam flour
Overall sensory acceptance scores with the same letter(s) are not significantly different ($P < 0.05$).
Source: Idowu *et al.* (1994).

* The quality of loaves decreased as the level of dilution of wheat flour with cocoyam flour increased.

1b. Doughnut

Doughnut is leavened in the same way as bread with yeast. It was produced by Lugbe *et al.* (2009) using wheat-detoxified cassava composite flours. The cassava mashes were fermented separately in 24 and 48 h using two species of microorganisms (Candida and Rhizopus). It was reported that doughnuts prepared by replacement of 10% wheat flour with cassava flour and fermented for 24 h with either of the microbes compared very well with 100% wheat flour doughnut without any impairment. Above 10% level of replacement negatively affected the doughnut quality.

Table 3: Panel mean scores for sensory characteristics of wheat-cassava composite doughnuts

Doughnut Samples	Colour	Taste	Flavour	Texture	Acceptability
WF	8.10[a]	8.20[a]	8.00[a]	8.60[a]	8.20[a]
CCF24	8.00[a]	720[b]	730[ab]	7.60[a]	760[b]
CCF48	730[ab]	6.30[c]	600[bc]	600[b]	650[b]
RCF24	620[b]	8.00a	8.00[a]	7.40[a]	8.0[a]
RCF48	630[b]	6.40[c]	670[b]	610[b]	6.0[a]

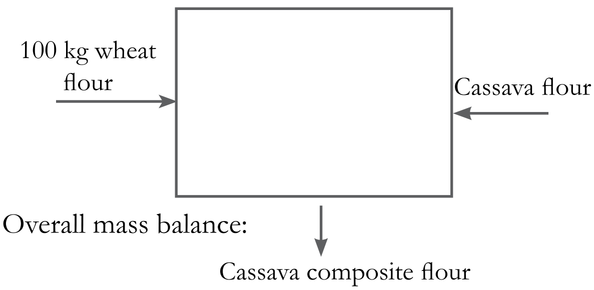
WF = Wheat flour doughnut. CCF24 = Composite flour doughnut containing 24 h candida fermented cassava flour. CCF48 = Composite flour doughnut containing 48 h candida fermented cassava flour. RCF24 = Composite flour doughnut containing 24 hours rhizopus fermented cassava flour. RCF48 = Composite flour doughunt containing 48 hours Rhizopus fermented cassava flour.

* The upper limit of non-wheat component (cassava) in composite flour doughnut is 10%.

Yeast leavened products such as bread lose their quality especially volume (the most generally used indicator of baking quality) when their gluten quantity is decreased. Blending of non-wheat flour with wheat flour dilutes the quantity of gluten proteins in wheat. The more the gluten is diluted by raising the ratio of non-wheat flour in the composite flour, the more the quality of yeast leavened baked product is decreased. Dobraszczyk

(2001) stated that wheat flour contains between 6% and 20% protein, most of which is in the form of gluten and bread of acceptable quality can only be produced with wheat flour containing at least 11% protein and, therefore, it is virtually impossible to produce bread of acceptable quality with wheat flour of protein equal or less than 8%.

Assuming composite flour for bread is to be produced from blends of wheat flour and cassava flour. And it is desired to produce wheat-cassava composite flour containing 11% wheat flour protein, the level of wheat protein required to produce bread of acceptable quality according to Dobraszcyzyk (2001). If high quality wheat flour containing 14% protein is used in the blend, the weight of cassava flour required to be blended into 100 kg of wheat flour to form wheat-cassava composite flour of 11% wheat protein could be calculated using material balance.



Overall mass balance:

100 + z = y .... (1)

Where z = mass of cassava flour, y is the mass of composite flour.

Mass balance on the wheat protein fraction

100(0.14)+ z(0) = y (0.11)

14 + 0 = 0.11y .... (2)

14 = 0.11y

y = 14/0.11 = 127.27 kg

Substituting the value of y in equation (1)

100 + z = 127.27

Z = 127.27 – 100 = 27.27 kg

The percentage of cassava in such composite flour based to that of wheat flour is

27.27/100 x 100% = 27.27%

Hence, incorporation of cassava flour below or equal to 27.27% in the wheat composite will produce acceptable bread. And incorporation of cassava above 27.27% will give a bread of low and unacceptable quality. Wheat containing 13% protein will be able to accommodate 18.18% of cassava flour to give good and acceptable bread loaves. The percentage of cassava flour could be raised if the composite flour is to contain 10% wheat protein and if the wheat flour is milled from high quality wheat grains containing more than 13% protein.

Production of wheatless or non-wheat flour bread

One hundred per cent non-wheat flour bread was reported to have been produced by Ayo *et al.* (2008) using a blend of acha (*Digitaria exilis Staph*) grains-potato flours (11:4) and treated with either of these three emulsifiers, Carboxyl Methyl Cellulose (CMC), Arabic Gum (AG) and Egg White (EW). The breads were produced from blend of the two flours using the principle ingredients (10% sugar, 1.0% salt, 1.5% yeast and 2.5% fat). Each improver or emulsifier was added at varied percentages (0, 2, 4 ..., 10%) to produce different loaves.

Table 4: Effect of carboxyl methyl cellulose (CMC) on the physical and sensory properties of acha-potato flour bread

CMC (%)	Loaf vol. (cm^3)	Specific Vol. (cm^3/g)	Pore Value	Baking Value	Ave. Colour	Ave. texture	Taste
0	396	1.75^{d}	4	238^{e}	570^{b}	4.00^{c}	430^{b}
2	468	1.89^{cd}	4	281de	552^{b}	457^{bc}	415^{b}
4	542	2.07^{bc}	5	380^{cd}	620^{b}	512^{bc}	530^{b}
6	605	216^{b}	6	484^{bc}	617^{b}	520^{bc}	515^{b}
8	650	224^{b}	6	520^{b}	6.25^{b}	550^{b}	515^{b}
10	683	2.24^{b}	6	546^{b}	5.05^{b}	530^{bc}	495^{b}
WF	946	3.91^{a}	8	898^{a}	8.25^{a}	7.80^{a}	8.0^{a}
LSD	—	0.24	—	130.1	1.31	1.49	1.48

WF = 100% wheat flour bread

Values on the same column followed by the same letter are not significantly different ($P < 0.05$)

Source: Ayo *et al.* (2008).

Table 5: Effect of Arabic Gum (AG) on the physical and sensory properties of acha-potato flour bread

AG (%)	Loaf Vol. (cm^3)	Specific Vol. (cm^3/g)	Pore Value	Baking Value	Ave. Colour	Ave. texture	Taste
0	400	1.80^d	3	200^d	4.73^{bc}	3.48^c	3.65^b
2	535	2.39^c	4	321^c	5.43^b	4.82^{bc}	4.50^b
4	465	2.70^b	5	326^v	4.20c	3.58^{bc}	3.70^b
6	601	272^b	6	481^b	4.45^{bc}	3.63^{bc}	3.45^b
8	608	270^b	6	486^b	4.48^{bc}	3.62^{bc}	3.80^b
10	614	2.69^{bc}	5	430^{bc}	4.97^{bc}	4.40^{bc}	4.20^b
WF	907	3.96^a	7	873^a	8.12^a	8.00^a	8.45^a
LSD	–	0.30	–	114.44	1.17	1.28	1.25

Source: Ayo *et al.* (2008).

Table 6: Effect of egg white on the physical and sensory properties of acha-potato flour bread

EW (%)	Loaf vol. (cm^3)	Specific Vol. (cm^3/g)	Pore Value	Baking Value	Ave. Colour	Ave. texture	Taste
0	416	1.84^c	4	250^d	4.28^d	3.92^c	3.95^d
2	484	2.07^c	5	339^c	5.30^c	5.25^c	5.15^c
4	550	2.29^{bc}	5	385^{bc}	6.05^{bc}	5.15^b	4.95^{cd}
6	640	2.52^b	5	448^b	6.30^b	5.65^b	5.30^c
8	798	3.00^b	3	399^b	6.67^b	5.30^b	6.85^b
10	805	3.02^b	3	387^b	6.89^b	5.35^b	6.92^b
WF	967	3.82^a	7	870^a	8.42^a	8.33^a	8.65^a
LSD	–	0.78	–	88.19	0.79	0.85	1.07

Source: Ayo *et al.* (2008).

The baking value (BV) ranged from 238 – 546, 200 – 486 and 250 – 448 for CMC, AG, and EW respectively with levels of the improvers from 0 – 10%. The wheat flour bread loaves had baking value (BV) of 870 – 896 and was rated as very good. EW-improved loaf with the highest loaf volume of 798 does not have the highest baking value as expected among other improvers used. The baking value at 6.0% and above of the egg white (emulsifiers) were rated as satisfactory.

* Gel forming substances such as emulsifiers or improvers are known to retain carbon dioxide formed during fermentation and temporarily bind water required for gelatinization of starch during baking (NRC, 1996). And these are two functions of wheat gluten during bread baking process.

Cassava-Soyabean flours bread

The Institute for Flour and Bread TND Wagenngen, Netherlands, had reported baking acceptable and good quality bread from composite flour mixture using cassava and soyabean flours in the ratio of 4:1. Glycerol monosterate (an emulsifier or improver) at 1.0% level of addition was used as gluten substitute. The cassava-soyabean flours dough according to the Institute is a semi-liquid that lacks cohesive and elastic properties and resembled conventional cake batters. Bread from the cassava-soyabean composite flour was rather made with cake baking equipment than the traditional bread making equipment because of the loaf resemblance to cake.

Composite flour cake

Composite flour cakes were produced from wheat-alum treated African breadfruit (T*reculia africana*) flours by Iheadiohanma *et al.* (2009) using combination ratios of 100:0, 75:25, 50:50, 25:75 and 0:100. They reported that the physical properties (weight and volume) of all the cake samples were similar as there were no significant differences ($P < 0.05$) in their physical properties. The reason for this is that cake is a product made from soft wheat flour batter. It does not require retention of gas (carbon dioxide) or proof as bread dough. However, the sensory quality attributes of the cakes from 50:50, 25:75 and 0:100 wheat-alum treated African breadfruit flour ratios were inferior to that of 100% wheat flour cake.

Composite flour biscuits

Unlike yeast leavened baked products, high quality and acceptable biscuits are reported to have been produced from wheat-non-wheat composite flours containing 50% and above non-wheat flours.

Iwe and Egwuekwe (2010) produced biscuits from the composite flour blends of wheat-*Xanthosoma sagitifolum* and wheat-*Colocasia esculenta* flours. They blended the wheat flour with each of the cocoyam species flours at the ratio of 100:0, 50:50, 25:75 and 0:100. The sensory evaluation results showed that the products were acceptable to the panelists. The 100% wheat flour biscuit was significantly better ($P < 0.05$) in appearance to all the biscuits except that of 25:75 wheat-*Xanthosoma* flour biscuit. The flavour of the biscuits from 100% wheat flour was significantly higher compared to 100% *Xanthosoma* and 25:75 wheat-*Colocasia* flours biscuits.

Table 7: Sensory evaluation results of biscuit produced from blends of wheat-*Xanthosoma* sagitfolium and wheat-*Colocasia esculenta* flours

	Sensory		Attributes	
Blends	Appearance	Flavour	Texture	Gen acceptability
100% Wheat	8.20^{a}	7.30^{a}	7.80^{a}	7.80^{a}
100% *Xanthosoma*	5.10^{d}	5.90^{b}	4.00^{d}	4.60^{d}
100% *Colocasia*	7.00^{b}	6.60^{ab}	6.70^{ab}	7.20^{ab}
75% *Xanthosoma*	7.20^{ab}	6.50^{ab}	6.40^{bc}	6.60^{bc}
75% *Colocasia*	5.50^{cd}	5.60^{b}	5.20^{cd}	5.50^{cd}
50% *Xanthosoma*	6.30^{bc}	6.40^{ab}	6.30^{bc}	6.40^{bc}

Means in the same column with different superscripts are not significantly different ($P < 0.05$)

Source: Iwe and Egwuekwe (2010).

Idowu *et al.* (1994) produced biscuits from three composite flours, wheat-*Colocasia esculanta A* (ede-ofe), wheat-*Colocasia esculenta B* (cocoindia), and wheat-*Xanthosoma sagitifolium* (ede uhe). The cocoyam biscuits were fragile and this reflected in flow and break strength which decreased with increasing dilution of wheat flour with cocoyam flours.

Biscuits from 100% cocoyam flours, generally, had low flow and break strength values, while 100% wheat flour biscuits had the highest flow and break strength values. The flow and break strength values of wheat-cocoyam biscuits, however, were lower than that of 100% wheat flour biscuits but higher than those of 100% cocoyam biscuits.

Table 8: Quality of wheat-cocoyam composite flour biscuits

Blends (%)	Biscuit Flow %	Break Strength (kg)	Sensory qualities Crispiness (9)	Colour (9)	Test (9)	Average (9)
Wheat						
100	68.7	3.25	7.3[a]	7.5[a]	7.6[a]	7.5[a]
Colocasia A						
60	63.5	1.90	7.3[a]	6.9[b]	7.1[a]	7.1[a]
80	56.4	1.75	7.8[a]	7.1[a]	7.6[a]	7.5[a]
100	30.5	1.00	6.9[b]	7.0[a]	7.6[a]	7.1[a]
Colocasia B						
60	62.7	1.45	7.1[a]	7.2[a]	7.2[a]	7.2[a]
80	55.2	1.05	7.0[a]	6.9[b]	6.5[b]	6.7[b]
100	31.6	0.83	6.6[b]	6.9[b]	6.5[b]	6.7[b]
Xanthosoma						
60	63.5	1.80	6.9[b]	7.0a	6.8[b]	6.9[b]
80	58.7	1.45	7.1[a]	7.1[a]	7.1[a]	7.1[a]
100	29.5	1.00	6.7[b]	6.4	7.1[a]	6.7[b]

Mean scores with same letter in a column are not significantly different (P < 0.05)

Source: Idowu *et al.* (1994).

Acceptable biscuits were reported to have been produced by Omeire and Ohambele (2010) from wheat flour substituted with 20% defatted cashew nuts flour. The table below is the sensory scores for quality attributes of the biscuits.

Table 9: Sensory scores of biscuits from wheat-defatted cashew nuts flours

Wheat-Cashew Nut flours Blends	Colour	Flavour	Texture	Gen. acceptability
100.0	7.15[a]	7.55[a]	7.15[ab]	7.60[a]
95:5	8.10[a]	7.35[a]	7.60[a]	7.85[a]
85:15	7.15[a]	7.77[a]	7.35[a]	7.85[a]
80:20	7.10[a]	6.75ab	6.90[b]	7.10[a]
75:25	7.50[a]	6.15[b]	6.05[c]	6.00[c]
70:30	7.35[a]	7.10ab	6.75[b]	7.00[b]

Means with the same column are significantly not different (P < 0.05)

Source: Omeire and Ohambele (2010).

Also brewers spent grain (BSG) have been used successfully as partial replacement for wheat flours in the production of high indigestible fibre bread and cookies by Gemah *et al.* (2010). Kissel and Prentice (1979) used BSG from 100% barley malt while Gemah *et al.* (2010) used BSG from 100% sorghum (70% unmalted and 30% malted sorghum).

Table 10: Physical properties of biscuit from wheat-brewers spent grains (BSG) composite flours

Samples	Weight (g)	Diameter (mm)	Thickness (mm)	Spread ration
100.0	7.70[a]	36.90[c]	9.125[a]	4.05[d]
90:10	7.48[a]	38.90[d]	9.00[a]	4.32[c]
80:20	7.20[b]	39.54[c]	8.96[ab]	4.41[bc]
70:30	6.86[c]	39.90[b]	8.86[c]	4.50[a]
0:100	5.34[d]	40.20[a]	8.40[d]	4.79[a]
LSG	0.25	0.20	0.14	0.10

Means along the column with the same letter arte not significantly different (P < 0.05).

Source: Gernah *et al.* (2010).

Possible challenges of the use of composite flour and blends of wheatless flours

These are possible challenges that may likely arise if the use of composite and wheatless flours are enforced for making of leavened and unleavened baked products in Nigeria.

1. There may not be adequate and ready availability of the non-wheat crops (e.g. cassava) for the production of composite flours.
2. Unwillingness of multinational companies operating in Nigeria to incorporate non-wheat flours for composite flour production, as this will reduce the quantity of wheat they import and the profit their parent companies make from sale of wheat.
3. Acceptability of the products baked with composite flours and blends of wheatless flours by Nigerians will be difficult. Most Nigerians have a penchant for imported items or foreign made products. They may find it difficult to accept composite flour and blends of wheatless flours for baked products unless adequate and vigorous sensitization is carried out.
4. Infrastructural problem such as lack of reliable power supply from Power Holding Company of Nigeria (PHCN) and public water supply especially for small and medium scale would-be operators who will like to venture into non-wheat flour milling business.
5. Detoxification to low and safe levels of the cyanide content of cassava if this crop flour is to be used as a component of the composite flour.
6. Competition between the consumers and processors of the non-wheat crop if the crop is consumed as a staple food. This would no doubt increase the cost of the staple food.
7. Possible sabotage from multinational flour milling companies through importation of low quality wheat for their mills since the percentage of non-wheat flour incorporated with wheat flour to form composite flour suitable for bread making depends on the quantity and quality of gluten protein.

Conclusion

Wheat flour can be substituted with the flours of virtually all the food crops grown in Nigeria, including brewers spent grains to at least 10% level to formulate composite flour which could be used to make high quality aerated food products. Composite flour containing 80% or less wheat flour can no doubt be used to make good quality bread provided the wheat flour in the composite flour has high quality and quantity (14% or more) of protein. Also, it is possible to bake good quality biscuits and cakes from composite flour having equal blends of wheat flour and local food flour as wheat flour containing as low as 6 – 7%. Protein could be used for making them. High quality wheat flour of 13% or above protein content when blended with local food flour such as cassava or cocoyam flour will give a composite flour containing at least 6% wheat protein.

Hence, if high quality wheat is imported and the flour blended with local food flours to produce composite flours, more than 20% and 50% of foreign exchange spent respectively for importation of wheat for bread making flour and importation of wheat for biscuit and cake making flours can be saved. This on one hand will create jobs for our teeming youths in agriculture and food processing industry and on the other hand save some foreign exchange which could be used to develop other areas of the economy.

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