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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Quality Characteristics of Cookies from Composite Flours of Watermelon Seed, Cassava and Wheat

S.C. Ubbor and E.N.T. Akobundu
Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria

Abstract: The use of composite flour from watermelon seed, cassava (TMS 99/6012 variety) low in cyanide and wheat in the production of cookies was investigated. The proximate composition and functional properties of the samples were determined. Quality of cookies made with the blends was evaluated by a 20-member sensory panel. The watermelon seed flour was blended with wheat and cassava flour at the ratios of 0:100, 10:90, 15:85, 20:80, 50:50 and 100:0, 90: 10, 85:15, 80:20, 50:50, respectively. The protein and fat content of WC_1 (watermelon seed flour/cassava flour, 90:10 ratio) was highest followed by WC_2 (watermelon seed flour/ cassava flour, 85:15). WM_3 cookies (wheat/watermelon seed flour, 80:20) ranked best in sensory evaluation conducted. All cookies were acceptable, scoring below 4.00 on a 9-point hedonic scale. Up to 20% wheat and 15% cassava flours could be replaced with watermelon seed flour in cookies.

Key words: Watermelon seed, cookies, composite flour,

INTRODUCTION

Composite flour can be described as a mixture of several flours obtained from roots and tubers, cereal, legumes etc with or without the addition of wheat flour (Adeyemi and Ogazi, 1985). It can also be a mixture of different flours from cereal, legumes or root crops that is created to satisfy specific functional characteristics and nutrient composition.

Cassava has been identified as the most important root crop in Nigeria in terms of food security, employment creation and income generation for many house-holds (Vijagolpal *et al*., 1988; Ugwu, 1996). It is a staple food in many poor and developing countries. Its major handicap is the presence of cyanogenic glycosides (linamarin and lotaustralin). However, several studies have shown that these cyanogenic glycosides are volatile and highly soluble in water and therefore easily eliminated by processing methods such as drying, soaking, and fermentation (Cardoso *et al*., 1999). One study has shown that some cassava varieties are naturally low in these cyanogenic glycosides thus enhancing their utilization in several food formulations (Ubbor *et al*., 2006).

Watermelon seed is reported to be high in protein and has excellent functional properties and has been found to be effective in baking (El-Adawy, 2001; Nasr and Abufoul, 2004). The fact that Nigeria does not grow wheat and relies heavily on importation of the commodity justifies the continued search for flour composites for local use.

Cookies in the United States and Canada are small, round and flat cakes commonly called biscuits elsewhere. Traditionally, cookies are made from wheat flour but could be produced from cassava flour and other composites (Cock, 1985; Oyewole *et al*., 1996).

The objectives of this work are to:

- Produce flours from cassava roots and watermelon seeds.
- Formulate flour composites of wheat/watermelon seeds and examine their proximate composition and functional properties.
- Produce cookies from the flour composites.
- Evaluate the quality of the cookies physically and sensorially.

MATERIALS AND METHODS

Fresh roots of cassava variety (TMS 99/6012) were obtained from National Root Crop Research Institute (NRCRI), Umudike and watermelon pods were purchased from Umuahia market both in Abia State, Nigeria.

Sample preparation

Cassava flour production: The cassava roots were harvested, peeled, washed and grated. The resulting mash was bagged in a sack and dewatered using hydraulic presser at the Garri Processing Unit of the NRCRI, Umudike. The dewatered cake was sun dried and then further dried effectively in thermo-regulated oven (Gallen, BS model 0v-160) at a temperature of 60°C for 3-4 h. The resulting material was milled and sieved into flour of 250 µm particle size. The flour was sealed in cellophane bag and stored at room temperature (25°C) until needed for further analysis (Fig. 1).

Production of watermelon seed flour: The watermelon seeds were extracted, washed, drained and dried at temperature of 60°C for 6 h. The dried seeds were milled and sieved through 60 mesh sieve. The

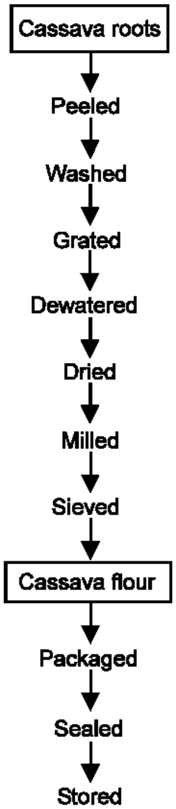

Fig. 1: Flow Chart for Production of High Quality Cassava Flour (HQCF)

watermelon seed flour was sealed in a cellophane bag and stored at room temperature (25^{o}C) for further analysis (Fig. 2).

Formulation of flour composites: Flour composites of wheat/water melon seed and cassava/watermelon seed were formulated (Table 1).

Proximate analysis of samples: The protein, fat, crude fibre, moisture contents were determined according to James (1995), while the carbohydrate was determined by difference. The total ash was determined according to Pearson (1976).

Evaluation of functional properties: The oil and water absorption capacities, bulk density, emulsion stability, emulsion capacity, wettability were determined according to the method described by Okezie and Bello (1988), the gelatinization temperature, gelation capacity were determined according to the method described by Sosulski *et al.* (1976). The foam stability and capacity, swelling index were determined according to the method described by Narayana and Narasinga (1982).

Sensory evaluation: The cookie quality was assessed by a test panel of 20 judges. Each product was evaluated by the panel of judges on a 9-point hedonic scale where 1 represented like extremely while 9 represented dislike extremely. The cookies were evaluated for quality characteristics such as colour, taste, texture, aroma, crispness and overall acceptability (Ihekoronye and Ngoddy, 1985). The scores were subjected to analysis of variance (ANOVA) and the treatment means separated using Duncan's multiple range tests.

Table 1: Formulation of composite flour

Blends	wheat	watermelon seed	cassava
W_1	100	-	-
W_2	-	100	-
W_3	-	-	100
WM_1	90	10	-
WM_2	85	15	-
WM_3	80	20	-
WM_4	50	50	-
WC_1	-	90	10
WC_2	-	85	15
WC_3	-	80	20
WC_4	-	50	50

Physical analysis of the sample: The biscuit break strength was determined according to the method of Okaka and Isieh, (1990). Analysis of variance (ANOVA) was carried out to test statistically the significance of any change in flow and break strength of the biscuit at 95% confidence level.

RESULTS AND DISCUSSION

Proximate composition of the samples: The results of the proximate composition of the samples are shown in (Table 2). This results show that the blend WC_1 (watermelon seed flour/cassava flour; 90:10) had the highest protein content while sample WC_4 (watermelon seed flour/cassava flour; 50:50) had the lowest. There was significant difference ($p \leq 0.05$) in protein content among the blends. The high protein content of the WC_1 (watermelon seed flour/cassava flour; 90:10) is due to the level of watermelon seed flour, which contains high protein content. According to Padmaja and Jisha (2005), protein content of the cassava based composite flours could be elevated through the incorporation of legume flours.

The blend WM_1 (wheat/watermelon seed flour, 90:10) had the highest carbohydrate content while the blend WC_1 (watermelon seed flour/cassava flour 90:10) had the lowest. There was significant difference ($p \leq 0.05$) among the blends and the high carbohydrate content of WM_1 and low carbohydrate content of WC_1 explain the difference.

There was high content of fat in WC_1 (watermelon seed flour/cassava flour 90:10), followed by WC_2 (watermelon seed flour/cassava flour 85:15) and then WC_3 (watermelon seed flour/cassava flour 80:20). There was

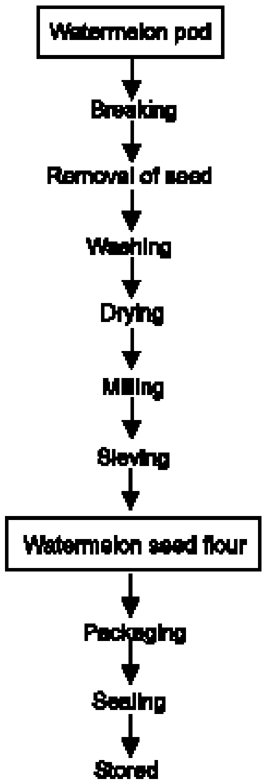

Fig. 2: Flow Chart for Production of Watermelon Seed Flour

significant difference among the blends. The WC_2 (watermelon seed flour/cassava flour 85:15) blend, had the highest moisture content followed by WM_4 (wheat/watermelon seed flour, 50:50), (watermelon seed flour /cassava flour 85:15) and WC_3 (watermelon seed flour /cassava flour 80:20).

The blend WC_2 had the highest crude fibre content while WM_2 had the lowest. The crude fibre content of W_2 is in line with the result of Nasr and Abufoul (2004).

The increase in crude fibre of WC_2, WC_3 and WC_4 may be as a result of increase in watermelon seed flour. From the result, there was a significant difference ($p \leq 0.05$) among the samples. It was also observed from the result that the ash content was highest in WC_2 than in W (wheat). There was a significant difference in the fibre content among the samples (Plate 1 and 2).

Functional properties of the samples: The results of the functional properties of the samples are shown in Table 3. The bulk density of the samples ranged from 0.595-0.725. WM_1 (watermelon seed flour/cassava flour, 80:20) sample had the highest bulk density among the blends while WC_4 had lowest. There was no significant difference among the blends within the composite flours. Bulk density gives an indication of the relative volume of packaging material required and high bulk density is a good physical attribute when determining the mixing quality of a particulate matter (Lewis, 1990). The values of the wettability ranged between 15.00 and 47.50 sec. WM_1 and WC_1 had the highest wettability while WC_3 (watermelon seed flour /cassava flour, 80:20) and WM_4 (wheat/watermelon seed flour, 50:50) had the lowest. There was significant difference among the other blends. Wettability is a function of ease of dispersing flour samples in water and the sample with the lowest wettability dissolve fastest in water.

The water absorption capacity of the blends was between 1.400 and 2.790. WC_2 (watermelon seed flour/cassava flour, 85:15) had the highest gelatinization temperature and WM_2 (wheat/watermelon seed flour (85:15) had the lowest gelatinization temperature. This result showed that the composite flours had good gelling property. Water absorption capacity is important in bulking and consistency of product as well as in baking applications (Niba *et al.*, 2001).

Plate 1: Cookies produced from composite flour
WM_1 = wheat : watermelon seed flour (90:10)
WM_2 = wheat : watermelon seed flour (85:15)
W_2 = watermelon seed flour (100:0)
W_3 = cassava flour (100:0)
WC_1 = watermelon seed flour: cassava flour (90:10)
WC_2 = watermelon seed flour: cassava flour (85:15)

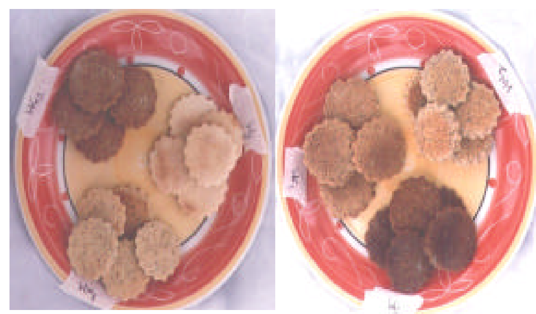

Plate 2: Cookies produced from composite flour
WM_3 = wheat : watermelon seed flour (80:20)
WM_4 = wheat : watermelon seed flour (50:50)
WC_3 = watermelon seed flour : cassava flour (80:20)
WC_4 = watermelon seed flour : cassava flour (50:50)
W_1 = wheat flour (100:0)

Table 2: Proximate composition of the samples

Samples	Protein	Moisture	Crude fiber	Fat content	Ash content	Carbohydrate
	(%)					
W_1	11.55^{i}	10.70^{bc}	4.23^{e}	42.78^{a}	4.660^{d}	8.94^{j}
W_2	28.66^{a}	9.77^{c}	0.65^{i}	0.64^{j}	2.150^{j}	84.57^{a}
W_3	2.23^{j}	9.77^{c}	0.65^{i}	0.64^{j}	2.150^{j}	84.57^{a}
Wm_1	13.34^{h}	10.18^{c}	3.92^{f}	6.23^{h}	2.680^{i}	63.64^{c}
Wm_2	14.52^{g}	10.05^{c}	3.80^{f}	8.15^{g}	2.830^{h}	60.65^{e}
Wm_3	15.66^{f}	9.97^{c}	3.90^{f}	5.77^{h}	3.055^{g}	61.65^{d}
Wm_4	18.72^{e}	9.77^{c}	4.84^{d}	11.92^{f}	4.460^{e}	50.29^{f}
Wc_1	26.25^{b}	10.03^{c}	3.30^{g}	36.78^{b}	3.820^{f}	19.82^{h}
Wc_2	25.00^{c}	12.05^{a}	5.72^{a}	35.24^{c}	6.335^{a}	15.66^{i}
Wc_3	23.80^{d}	11.72^{ab}	5.26^{c}	33.17^{d}	6.035^{b}	20.02^{h}
Wc_4	13.13^{h}	10.71^{bc}	5.51^{b}	21.52^{e}	5.740^{c}	43.39^{g}

Means of duplicate determination, Means with the same superscripts within the column are not significantly different ($p \leq 0.05$)

W_1 = wheat flour (100:0)
W_2 = watermelon seed flour (100:0)
W_3 = cassava flour (100:0)
WM_1 = wheat/watermelon seed flour (90:10)
WM_2 = wheat/watermelon seed flour (85:15)
WM_3 = wheat/watermelon seed flour (80:20)
WM_4 = wheat/watermelon seed flour (50:50)
WC_1 = watermelon seed flour/cassava flour (90:10)
WC_2 = watermelon seed flour/cassava flour (85:15)
WC_3 = watermelon seed flour/cassava flour (80:20)
WC_4 = watermelon seed flour/cassava flour (50:50)

Table 3: Functional properties of the samples

Sample	Bulk Density	Wettability	Gelatinization Temp.	Swelling Index	Gelation Capacity
W_1	0.619^{ab}	22.50^{def}	62.00	2.360^{b}	1.50
W_3	0.595^{b}	32.50^{bc}	62.00	2.160^{b}	0.50
W_3	0.595^{b}	32.50^{bc}	62.00	2.160^{b}	0.50
Wm_1	0.695^{ab}	37.50^{b}	60.00	1.205^{e}	0.50
Wm_2	0.671^{ab}	32.50^{bc}	58.00	1.390^{de}	1.00
Wm_3	0.653^{ab}	30.50^{bcd}	61.00	1.705^{cd}	1.00
Wm_4	0.657^{ab}	18.00^{ef}	64.00	2.020^{bc}	2.00
Wc_1	0.691^{ab}	37.50^{b}	64.00	1.155^{e}	0.50
Wc_2	0.628^{b}	25.00^{cde}	69.00	2.225^{b}	0.50
Wc_3	0.725^{a}	15.00^{f}	68.00	2.970^{a}	1.00
Wc_4	0.666^{ab}	15.00^{f}	65.00	2.055^{bc}	0.50

Sample	WAC	OAC	Emulsion Capacity	Emulsion Stability	Foam Capacity	Foam Stability
W_1	2.600^{a}	1.830^{c}	17.75^{def}	16.53^{a}	14.625^{abcd}	7.16^{cdef}
W_3	2.200^{bc}	1.570^{f}	16.14^{f}	11.04^{bc}	13.700^{bcd}	8.57^{bc}
W_3	2.200^{bc}	1.570^{f}	16.14^{f}	11.04^{bc}	13.700^{bcd}	8.57^{bc}
Wm_1	1.200^{fg}	1.770^{d}	22.14^{b}	16.28^{a}	16.060^{ab}	8.22^{bc}
Wm_2	1.190_{g}	2.170^{a}	20.09^{bc}	17.19^{a}	10.665^{e}	9.04^{b}
Wm_3	1.970^{de}	1.480^{g}	18.89^{cde}	8.86^{d}	13.660^{bcd}	6.63^{def}
Wm_4	1.400^{f}	1.580^{f}	15.50^{f}	9.15^{cd}	14.780^{abc}	8.04^{bcd}
Wc_1	1.800^{e}	1.460^{h}	20.35^{bc}	12.74^{b}	12.970^{cde}	7.43^{cdef}
Wc_2	2.390^{b}	1.770^{d}	19.07^{cd}	10.94^{bc}	12.095^{de}	6.16^{f}
Wc_3	2.140^{cd}	1.740^{e}	18.79^{cde}	9.18^{cd}	14.625^{abcd}	7.16^{cdef}
Wc_4	2.790^{a}	1.370^{i}	16.74^{ef}	10.77^{bcd}	13.700^{bcd}	8.57^{bc}

Means of duplicate determination, Means with the samesuperscripts within the column are not significantly different ($p \leq 0.05$)

W_1 = wheat flour (100:0)
W_2 = watermelon seed flour (100:0)
W_3 = cassava flour (100:0)
WM_1 = wheat/watermelon seed flour (90:10)
WM_2 = wheat/watermelon seed flour (85:15)
WM_3 = wheat/watermelon seed flour (80:20)
WM_4= wheat/watermelon seed flour (50:50)
WC_1 = watermelon seed flour /cassava flour (90:10)
WC_2 = watermelon seed flour /cassava flour (85:15)
WC_3 = watermelon seed flour /cassava flour (80:20)
WC_4 = watermelon seed flour /cassava flour (50:50)

The swelling index of the sample ranged from 1.155-2.970 among the blends. WC_3 (watermelon seed flour/cassava flour, 80:20) had the highest swelling index while WC_1 (watermelon seed flour/cassava flour, 90:10) had the least. There was significant difference among the blends. High swelling capacity has been reported as part of the criteria for a good quality product (Achinewhu *et al.*, 1998).

The gelation capacity ranged from 0.5-2.5. WM_4 (wheat/watermelon seed flour, 50:50), had the highest gelation capacity. WC_1 (watermelon seed flour/cassava flour, 90:10), WC_2 (watermelon seed flour/cassava flour, 85:15), WC_4 (watermelon seed flour/cassava flour, 50:50) and WM_1 (wheat/watermelon seed flour, 90:10) had the lowest gelation capacity. There was significant difference among the blends. Gels primarily enhance

Table 4: Sensory evaluation of the samples

Samples	Colour	Taste	Texture	Crispness	Aroma	Overall Acceptability
W_1	2.50^{b}	3.05^{bc}	3.05^{ab}	3.15^{bcd}	2.95^{ab}	3.00^{bc}
W_2	3.95^{a}	4.75^{a}	3.85^{a}	2.95^{bcd}	4.05^{a}	4.50^{a}
W_3	3.45^{ab}	4.05^{ab}	3.75^{a}	3.95^{ab}	3.35^{ab}	3.90^{ab}
WM_1	2.50^{b}	2.80^{bc}	3.25^{ab}	3.45^{bc}	3.15^{ab}	2.90^{ac}
WM_2	3.60^{ab}	3.05^{bc}	4.00^{a}	4.55^{a}	3.20^{ab}	3.75^{ab}
WM_3	2.55^{b}	2.55^{c}	2.15^{b}	2.05^{d}	2.55^{b}	2.40^{c}
WM_4	3.15^{ab}	2.95^{b}	3.00^{ab}	2.25^{d}	2.85^{ab}	3.10^{bc}
WC_1	2.85^{ab}	2.85^{bc}	2.80^{ab}	2.75^{cd}	2.85^{ab}	2.85^{bc}
WC_2	3.45^{ab}	3.60^{abc}	2.85^{ab}	2.45^{cd}	3.45^{ab}	3.40^{abc}
WC_3	3.40^{ab}	3.70^{abc}	3.95^{a}	2.85^{bcd}	3.70^{ab}	3.75^{ab}
WC_4	2.85^{ab}	3.25^{bc}	2.75^{ab}	2.30^{cd}	2.90^{ab}	3.45^{abc}

Means of duplicate determination, Means with the samesuperscripts within the column are not significantly different ($p \leq 0.05$)

W_1 = wheat flour (100:0)
W_2 = watermelon seed flour (100:0)
W_3 = cassava flour (100:0)
WM_1 = wheat/watermelon seed flour (90:10)
WM_2 = wheat/watermelon seed flour (85:15)
WM_3 = wheat/watermelon seed flour (80:20)
WM_4= wheat/watermelon seed flour (50:50)
WC_1 = watermelon seed flour /cassava flour (90:10)
WC_2 = watermelon seed flour /cassava flour (85:15)
WC_3 = watermelon seed flour /cassava flour (80:20)
WC_4 = watermelon seed flour /cassava flour (50:50)

the body and texture of a food product. The results indicate that the composite flours have good gelling capacity.

The oil absorption capacity ranged from 1.370-2.170. WM_2 (wheat/watermelon seed flour, 85:15) had the highest oil absorption capacity while WC_4 (watermelon seed flour/cassava flour, 50:50) had the lowest. There was a significant difference among the different blends. Oil flavours and gives soft texture to food. Absorption of oil by food products improves mouth feel and flavour retention. The high oil absorption capacity suggests the lipophilic nature of the flour constituents of the flour. The increase in oil absorption may also be attributed to the presence of more hydrophobic proteins which show superior binding of lipids (Kinsella, 1976).

The emulsion capacity of the different blends ranged from 15.20-22.14. WM_1 (wheat/watermelon seed flour; 90:10) had the highest emulsion capacity while WM_4 (wheat/watermelon seed flour; 50:50) had the lowest. There was significant difference ($p \leq 0.05$) among the blends. High emulsion capacity is an indication that the flour samples could be an excellent emulsifier in various foods (Akobundu *et al.*, 1982).

The emulsion stability of the blends ranged between 8.86 and 17.19. WM_2 (wheat/watermelon seed flour, 85:15) had the highest while WM_3 (wheat/watermelon seed flour (80:20)) had the lowest. There was significant difference ($p \leq 0.05$) among the blends.

The result of the foam capacity ranged from 12.095-16.060. WM_1 (wheat/watermelon seed flour, 90:10) had the highest foam capacity while WC_2 (watermelon seed flour/cassava flour, 85:15) had the lowest foam capacity. There was significant difference ($p \leq 0.05$) among the blends.

The foam stability of the different blends ranged from 6.16-9.04. WM_2 (wheat/watermelon seed flour, 85:15) had the highest foam stability while WC_2 (watermelon seed flour/cassava flour, 85:15) had the lowest. There was significant difference ($p \leq 0.05$) among the blends. Good foam capacity and stability are desirable attributes for flours intended for the production of variety of baked products such as angel cakes, muffins, cookies, fudges, *akara*, etc and also act as functional agents in other food formulations (El-Adawy, 2001).

Sensory evaluation: The results of the sensory evaluation of the cookie samples are presented (Table 4). Colour is an important sensory attribute of any food because of its influence on acceptability. The old adage that the eye accepts the food before the mouth is very true. The brown colour resulting from Maillard reaction is always associated with baked goods. The cookies scored between 2.50 and 3.95 on the 9 point-hedonic scale indicating that the cookies were at least liked slightly and agrees with the observations of Iwe (2007). There were significant differences among the cookie samples. The colour of the all wheat cookies was superior to the all cassava and all watermelon seed flour cookies. The cookie with 10% replacement of wheat flour with watermelon seed flour had the least score for colour and replacement of wheat flour with up to 20% watermelon seed flour did not significantly affect the colour of the cookies (Table 4).

Aroma is another attribute that influences the acceptance of baked good even before they are tasted. Substitution of wheat flour with either watermelon seed flour or cassava flour at different levels did not significantly ($p \leq 0.05$) affect the sensory scores of aroma. The highest score of 4.05 (like slightly) in aroma was obtained for cookie of all watermelon seed flour while the cookie with 20% watermelon seed flour replacement of wheat flour had the best aroma of 2.55 (Table 4).

Crispness is a desirable quality of cookies. Crispness scores were significantly ($p \leq 0.05$) superior in cookies with cassava flour replacement of wheat flour than in cookies with watermelon seed flour. The high fat content of watermelon seed flour was obviously responsible for the higher scores and less crispness. The effect of fat on biscuit texture and other baked goods is well known. Cookies with 20% watermelon seed flour replacement of wheat flour had the best texture with a score of 2.05. There was significant difference ($p \leq 0.05$) in the texture of the cookie samples but all the cookies were at least liked slightly (Table 4).

The cookies in which watermelon seed flour replaced wheat flour tasted better than those replaced with cassava flour. The cookies with 20% watermelon seed flour was the best in overall acceptability. The result confirmed that the quality of colour, aroma, crispness, texture and taste indeed influence the overall acceptability of the cookies. Wheat flour could therefore be replaced with up to 20% with watermelon seed flour and 15% cassava flour in cookie production without affecting the sensory qualities.

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