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Effects of Grain Germination on Some Physical, Chemical and Sensory Qualities of *Kunun* Produced Using Selected Cereals

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Abstract: Increasing preference for natural food products irrespective of civil affiliation, economic or social status necessitate the improvement of indigenous food products using inexpensive and effective technology such as germination that by no means erode the native nutritional status of the food. Studies on production of *Kunun* showed that preparation using germinated maize and sorghum possessed superior physical and chemical properties principally hydrolyzed total sugar without diminishing the phenolic and protein contents in comparison to products prepared using millet, the traditional choicest grain for preparation of *Kunun* under the conditions employed in this study. Statistical analysis (P = 0.05) of sensory scores revealed variable results on evaluated sensory attributes. This study provides information that could be useful for process manipulation in terms of selection of grains where the alternatives are cheap and treatment that offers reduction of production cost.

Key words: Cereal grains · germination · *Kunun* · quality assessment · natural food drink

INTRODUCTION

Cereal food drink called *Kunun* is indigenous to Northern Nigeria but widely consumed throughout Nigeria. The foremost cereals of choice in preparation of *Kunun* are millet, sorghum and maize in decreasing order of preference [1]. The following attributes make *Kunun* a delight beverage food drink: (i) Always consumed in liquid state (ii) Exert non-stimulating effect (iii) Consumed as relish (iv) Non-carbonated (v) Consumed for its thirst-quenching properties.

Kunun is superior to fizzy drink of non-natural origin because it is all-natural food and does not undergo severe process conditions, thus should retain much of its native fine nutrients. Fine nutrients are known and unknown bioactive factors required for proper physiological activities of a living system. Usually, fine nutrients are vulnerable to destruction or denaturation with loss or decimation of activities by nearly all processing methods.It is clear that bioactive components in foods significantly modify physiological factors such as: immune system, hormones, enzymes and their equals which are very crucial in maintenance or break down of good health. Unfortunately, most of the fine nutrients are heat labile, therefore the lesser the amount of heat applied the higher the probability of retention and activities of inherent fine nutrients of the food.

Although, *kunun* is "all-natural" food drink, however, the use of refined sugar as sweetener vitiate our claim of the all natural food drink in absolute term and where potato is used to sweetened necessitate additional cost and process effort. Germination is an inexpensive and effective technology for improving nutrients availability and diminishing anti-nutritional factors in cereal [2]. The biochemical, morphological and hormonal changes during germination have been reviewed by Simon [3]. By principle, hydrolysis of biomolecules is the basis of the improved availability of nutrients that may impact sensory attribute that may obviate the needs for the use of refined sugar for improving taste of *kunun* thereby affirming the status of *kunun* as "all-natural" food drink.

In this report, we present our findings on influence of germination on physical, chemical and sensory attributes of *kunun* produced using the foremost three cereal grains of choice for preparation of *kunun*.

MATERIALS AND METHODS

Materials: Foremost three cereal grains were chosen for preparation of *kunun* namely millet (*Eleusine coracana)*, maize *(Zea mays)* (white and yellow varieties) and sorghum *(Sorghum bicolor)* (white and red varieties), ginger (*Zingiber officinale*), pepper and related spices of natural origin were purchased at Ado-Ekiti central

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Table 1: Proportion of major ingredients for preparation of *kunun*

Ingredient	Quantity (g)
Cereals grain	200
Ginger	5
Flavour additives	1

Germinated Millet (ML-G), Millet (ML), Germinated White Maize (WM-G), White Maize (WM), Germinated Yellow Maize (YM-G), Yellow Maize (YM), Germinated Red Sorghum (RS-G), Sorghum (RS), Germinated White Sorghum (WS-G), White Sorghum (WS)

commercial market. The proportion of major ingredients used is given in Table 1. No refined sugar or sweet potato was used.

Preparation of *Kunun*: Adopted for preparation of *kunun* essentially was the improved production process reported by Gafa and Ayo [4] with modification for use of high temperature steeping process to obviate the need for use of chemical preservative in water and germination (Phase I and early part of phase II) was employed to effect saccharification. Volume of products was measured and taken as yield. Products in this study were not fermented.

Germination procedure: Each variety of the cereal grains (200 g) used in this study was rinsed in distilled water and drained. Steeping was actualized at a temperature of 48°C till moisture content of 42-45% was achieved and the water drained. Germination was carried out by spreading the steeped grains on a tray in a wood germination chamber at room temperature (28±2°C). The seeds were sprayed intermittently with water to actualize moist grains. Germinated grains were recovered when the radicle was about 1.5mm in length.

Analytical methods: Determination of titratable acidity: Drink samples were titrated with standard alkaline. Results were expressed in mg lactic acid equivalent/ml of food drink [5].

Measurement of pH: The pH of samples were measured using omega H. HP_x digital pH meter. Standardization of the meter was done using buffer solution of pH 4 and 9.

Determination of soluble solids: Soluble solids of samples filtrate were measured using hand refractometer at 28°C. Results were reported in degree brix.

Determination of total solid and water content: Total solid and water content of drink samples were determined using weight reduction method according to the method of AOAC [5].

Evaluation of total phenolic content: Total phenolic contents were evaluated according to the method described by Taga *et al.* [6]. Briefly, A 100 µl of Folin-Ciocalteau reagent (2N wrt acid Fluka Chemic AG-Ch 9470 BUCHS) was added to each sample (20 µl) and well mixed after addition of 1.58ml of water. After 30 seconds, 300 µl of 20% sodium carbonate solution was added and the sample tubes were left at room temperature for 2h. The absorbance (A) of the developed blue colour was measured at 700nm using Unicam Helios & UV/VIS/Spectrophotometer. A plot of A_{700nm} against corresponding concentration was used to calculate phenolic content (g/g ascorbic acid equivalent).

Determination of protein content: Protein content was determined by modifying the Bradford [7] dye method using egg albumin as standard.

Total sugar determination: Total sugar was determined according to the method of Dubois *et al.* [8] with slight modification. Samples were thoroughly mixed with ethanol and diluted with water appropriately and filtered prior to addition of phenol and concentrated sulphuric acid and the absorbance read at 490nm after 10 min. Sugar content was calculated using a standard curve prepared using 0-100 µg glucose.

Assessment of selected sensory characteristics of *kunun*: Selected sensory characteristics namely taste and colour of *kunun* drinks produced from non-germinated and germinated grains were determined subjectively following the procedure of Demooy and Demooy [9]. The taste was rated in degree of sweetness as detected by palate. Colour was described in degree of brown, yellowish and grayish appearance as adjudged by the eye.

Sensory evaluation: Using multiple comparison test, sensory evaluation of the different *kunun* food drinks was carried out by eight trained panelists comprised of students of the Dept. of Food Technology, Federal Polytechnic, Ado-Ekiti. Sensory attributes evaluated were: taste, mouth feel, colour, odour and overall acceptability using a score scale of 1 to 7 where 1 indicates extremely like and 7 indicates extremely dislike [10].

Statistical analysis: One way analysis of variance (ANOVA) using repeated measures was conducted. When significant (P = 0.05) difference were observed, means were separated using Tukey's test [11].

RESULTS AND DISCUSSION

The results of physical and chemical analysis of *kunun* produced using varieties of choicest cereal grains are presented in Table 2. The value of titratable acidity (mg lactic acid equivalent/ml of sample) range 1.169-3.510 with mean titratable acidity of 2.117. Generally, titratable acidity (1.4034-3.510) of products made using germinated grains appeared to be higher than titratable acidity (1.170-2.691) of products prepared using non-germinated grains. This trend of results may be due to hydrolysate of biomolecules released by the enzymes lipase and secondary oxidation of products released by amylase enzyme. Berrie [12] stated that during phase I and early part of phase II of germination, seed change from being biologically inert to becoming a fully integrated and actively metabolizing axis. Trigger for germination may be 'pre' or 'pro' formed 'Zymogen' which is activated on hydration or may be created 'de novo'. RS-G and YM-G had the highest titratable acidity; 3.510 and 3.276 respectively. RS and WM were individually characterized with the least amounts (1.169) of titratable acidity.

The pH of all the products range from 5.50 to 6.25 with calculated pH average of 5.855. The pH of 5.75 (Table 2) obtained for *kunun* made using sorghum is in tandem with pH of sorghum *kunun* drink earlier reported by Osuntogun and Aboaba [13]. Examination of the order of pH (Table 2) showed that preparations using germinated grains were characterized by lower pH. The result parallel higher acidity (Table 2) obtained for products prepared using germinated grains. Thus pH may be used as index of acidity during preparation of *kunun*.

The opaque appearance of the *kunun* drinks made it necessary to use their supernatant for evaluation of soluble solid of the products. Soluble solids (°Brix) of the products range from 1.5 to 8.0. The results of *kunun* preparation using germinated grains showed higher amounts (6.8-8.0) of soluble solids compared to lower amounts of soluble solids (1.5-4.2) of products prepared using non-germinated grains. The trend of result may be due to the effect of hydrolytic enzymes generated by germination process. Drink produced using YM-G had the highest amount (8.0) of soluble solids and the least amount (1.5) of soluble solids was obtained for each products prepared using WS and RS.Total solid (%) and water content (%) of the food preparations range 0.28-9.49 and 90.51-99.72, respectively. The value of the parameters is independent of either germination or non-germination but a function of amount of water added during processing and consistency of drying method employed during assessment.

The yield (litres) of the products range from 1.282 to 1.662. The results (Table 2) showed that products prepared using germinated grains gave lower yield compared to higher yield of products prepared using corresponding non-germinated grains. In our opinion,

Table 2: Physical and chemical [a]characteristics of *kunun*

[b]Sample	Yield (L)	Total solid (%)	Water content (%)	PH	Soluble solid (°Brix)	Acidity (mg ml^{-1})
ML-G	1.282	5.76	96.24	6.0	60	1.4038
WM-G	1.377	5.81	94.19	5.5	6.5	1.8718
YM-G	1.32	2.33	97.67	6.0	80	3.2763
RS-G	1.491	3.93	96.07	5.5	6.5	3.5100
WS-G	1.32	5.32	94.68	5.55	60	3.0400
WS	1.51	3.46	96.54	5.75	1.5	1.6379
RS	1.662	7.9	92.10	5.75	1.5	2.6910
WM	1.32	2.33	97.67	6.25	40	1.1699
YM	1.377	7.27	92.73	6.25	40	1.1699
ML	1.349	9.49	90.51	6.00	4.2	1.4038
Range germinated	1.282-1.491	N.R	N.R	5.50-6.00	6.00-8.00	1.4038-3.510
Range non-germinated	1.320-1.662	N.R	N.R	5.55-6.25	1.50-4.20	1.1699-2.691
Mean germinated	1.358	N.R	N.R	5.71	6.60	2.620
Mean non-germinated	1.444	N.R	N.R	6.00	3.04	1.6145
CV germinated	6%	N.R	N.R	4.65%	12.45%	35.39
CV non-germinated	9.84%	N.R	N.R	3.61%	46.33%	39.16

a Average of three determinations

b See Table 1 for interpretation of sample codes.

c Lactic acid equivalent

N.R. = Not required

Table 3: [a]Characteristics of selected nutrient-health promotion factors of *kunun*

[b]Sample	[c]Phenolic content (mg ml^{-1})	Total sugar (%)	[d]Protein (mg ml^{-1})
ML-G	5.66m	1.56	0.065
WM-G	3.92	1.60	0.068
YM-G	4.10	1.68	0.058
RS-G	5.30	1.60	0.070
WS-G	5.96	1.98	0.063
WS	5.42	0.05	0.056
RS	4.10	0.05	0.070
WM	5.42	0.78	0.068
YM	4.02	1.60	0.058
ML	4.02	1.48	0.070
Range germinated	3.92-5.96	1.56-1.98	0.058-0.07
Range non-germinated	4.02-5.42	0.05-1.60	0.058-0.07
Mean germinated	4.988	1.684	0.0.648
Mean non-germinated	4.596	0.792	0.0644
CV germinated	18%	10.16%	0%
CV non-germinated	16.38%	94.22%	0%

a Average of three determinations

b See Table 1 for interpretation of sample codes

c ascorbic acid equivalent

d egg-albumin equivalent

Table 4: Selected sensory characteristics of *kunun*

[a]Sample	Taste	Colour
WM	binsipid	Brownish white
WM-G	Sweet	Brownish white
RS	Insipid	Reddish brown
RS-G	Slightly sweet	Light reddish brown
WS	Insipid	Brownish white
WS-G	Slightly sweet	Bleached brown white
YM	Insipid	Butter yellow
YM-G	Sweet	Butter yellow
ML	Insipid	Ash white
ML-G	Insipid	Ash white

[a]See Table 1 for interpretation of sample codes (re-arrangement for comparison)

[b]with respect to sweetness

Table 5: Analysis of variance (ANOVA) of sensory scores ($P \leq 0.05$) of *kunu:* F value of judge and sample scores aspects

	Judge		Sample	
Quality attributes	F_{cal}	F_{tab}	F_{cal}	F_{tab}
Colour	1.84	2.2	*105.15	2.1
Odour	0.97	2.17	*12.17	1.96
Taste	2.15	2.17	*346.47	1.96
Mouthfeel	200.00	246.00	1284.00	12.91
Overall acceptability	97.00	217.00	*57.79	2.00

Significantly different ($P \leq 0.05$)

though yield is predominantly a function of amount of added water during milling, but the amount of raw *kunun* to be added to cooked portion during preparation to set gelatinization back is informed by the viscosity of heated product and gelatinization of starch is affected by the amount of starch in cereal slurry. Thus the lower yield of *kunun* recovered from preparation using germinated grains is probably due to reduction in amount of starch due to the induced enzymic degradation of the biopolymer in the slurry. In overall, the yield (Table 2) of products obtained using either non-germinated or germinated grains is encouraging for commerce. Consideration of selected nutrient-health promotion factors (Table 3). Among the bioactive-nutrient promotion factors, phenolics are the recently most focused for their therapeutics roles in management of degeneration and age-related diseases. Phenolics and their glycosides in plant foods are known for antioxidant activities [14;15]. The phenolic content (mg ascorbic acid equivalent/ml) of products prepared using germinated and non-germinated grains range 3.92-5.96 and 4.02-5.42 respectively, with calculated averages of 4.998 and 4.596, respectively. By principle, germination should lead to degradation in phenolic content of the pericarp/testa of cereals. Since germination did not culminate to reduction in phenolic content of products, it informed that germination must have improved phenolic compounds within the endosperm that surpass the amount degraded in the testa. Because germination parsed as transformation of seed from biologically inert to actively metabolizing axis [12] should because of biological tenderness synthesis and release defense chemical in nature of phenolics or compound such as polyketide with such property, in defense against biological attack or environmental stress. The amounts (0.056-0.0695) of protein content (mg egg albumin equivalent/ml) appeared to be similar irrespective of the type of cereal grain used. Thus effect of germination on magnitude of protein content of products appeared to be marginal.

Germination increased the total sugar content of *kunun*. Total sugar (%) content range 1.56-1.98 and 0.05-1.60 for preparations using germinated and non-germinated grains respectively. Products prepared using WS-G and YM-G were associated with the highest amount (1.98, 1.68) of total sugar and products prepared using WS and RS individually had the least amount (0.048) of sugar. With the exception of product made using millet, the proportion of total sugar released due to germination was several times higher than the total sugar in their corresponding products prepared using non-germinated

Table 6: Sensory [a]scores of *kunun*

Sensory parameter	ML-G sample	WM-G sample	YM-G sample	RS-G sample	WS-G sample	WS sample	RS sample	WM sample	YM sample	ML sample
Odour	4.375a	4.750a	4.125a	4.000a	4.750a	1.875b	1.750b	2.125b	1.750b	1.750b
Colour	1.125c	2.750b	8.625b	3.625b	3.625b	3.625b	3.625b	2.750b	8.625a	1.125c
Taste	7.500b	1.250 cd	1.000d	1.875c	1.750cd	7.250b	7.250b	8.000ab	8.125ab	8.625a
Mouth feel	1.800a	1.795a	1.800a	1.810a	1.800a	1.8100a	1.800a	1.800	1.790a	1.793a
Overall acceptability	1.375c	1.000d	5.875a	1.500c	1.125d	3.000b	3.375b	2.500bc	5.760b	5.740b

[a]See Table 1 for interpretation of sample codes: Means within a row for each preparation followed by same letter are not significantly different at 5% level of probability by Tukey's test. Low sensory score implies greater preference

grains. Data in Tables 2 and 3 showed that there are no two (non-germinated and germinated) groups of *Kunun* preparations with same physical and chemical characteristics. Therefore, extent of variation in the parameters is expressed in terms of coefficient of variation.Effects of germination on taste and colour attributes of product prepared were evaluated subjectively and described for comparative analysis (Table 4). Germination improved taste of products in the following order: Maize>sorghum>millet. The result is in agreement with findings (Table 3) of objective evaluation. In further support of this finding, the two physiological changes accompanying phase I and early part of phase II of germination are hydrolysis of biopolymers and synthesis of bioactivators. The changes should lead to hydrolysate (majorly sugar) that can impact desirable sensory attributes especially with respect to taste.

In order to assert the veracity of significance in the subjective findings, samples were rated using standard method. Scores were subjected to analysis of variance ($P \leq 0.05$). Consistency of judges rating of samples were validated (Table 5). Sensory scores of *kunun* prepared using non-germinated and germinated cereal grains are presented in Table 6. The low sensory scores for samples implied higher preference for samples.

Regarding colour, *kunun* produced using ML irrespective of germination was adjudged the most preferred. And drink prepared using YM irrespective of germination was least preferred. Therefore, preference for colour is related to the type of cereal grain, each possessing characteristic seed coat colour which ultimately influenced the colour of *kunun* product but independent of germination. No significant difference was observed in products prepared using WM, WS and RS and their corresponding prepared products irrespective of germination.

Besides, there was a significant difference in odour of drinks produced using germinated and non-germinated grains. Better odour was statistically found in favour of preparation using non-germinated grains. There is coherence in this result and titratable acidity in Table 2. The result is likely to be due to the product of the action of lipolytic enzymes generated during germination.

Judges in their assessment were unable to detect significant difference in mouth feel of products produced using germinated and non-germinated grains.

Generally, preparations obtained using germinated grains were significantly better in taste than corresponding products made using non-germinated grains. However, products prepared using millet was an exception to the observation. Therefore, we suggest that the least sweet taste of product prepared using germinated millet could have been due to the higher phenolic content of the grains as informed by its highest surface area among the grains. The high phenolic content (Table 3) of millet preparations supports the explanation. In addition, millet should contain the highest amount of chlorophyll among the grains used because of its greenish-like appearance among the used grains. The two must have suppressed the effect of germination on improvement of taste of drink prepared using millet. Our guess awaits validation. In order of sweetness, WM-G, RM-G, WS-G and RS-G appeared on the score Table 6. Overall acceptability assessment favours *kunun* products prepared using WS-G and WM-G as best these were followed by products prepared using ML-G, RS-G and preparation using YM-G was rated least.

CONCLUSION

Germination of the foremost three cereal grains of choice for production of *kunun* significantly modified the physical, chemical and sensory characteristics of the *kunun* produced using the grains. The simple and effective technology could be harnessed to enhance the production and quality of *kunun* to a status of all-natural food drink.

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