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A COMPARATIVE STUDY OF THE IMPACT OF CONTINUOUS AND BATCH PROCESSES ON THE DIASTATIC (THERAPEUTIC) ACTIVITIES OF TSIRO

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ABSTRACT

The diastatic indices (TSS, R-index, pH and water absorption capacity) of malted rice grains (24 – 120h sprouting, giving samples A – E respectively for each day) were measured after mixing each with 10g of whole maize flour and 150ml distilled water followed by incubation for 120min at 50^{0}C. Following the result of this preliminary work, four portions (2g each) of sample D (sprouted for 96h) were weighed out and each added to separate 150ml of wet milled sorghum (at the point of loading of tsiro) for kunu production. They were all incubated at 50^{0}C for 60, 80, 100 and 120min. These (batch process) experiments were repeated at 40, 45 and 55^{0}C. Employing a device for continuous conversion process, designed and fabricated for this research, the experiments with sample D above were done all over. All kunu samples were subjected to (TSS, solubility pH and spectrophotometry) tests, with those from continuous operation experiments further subjected to sensory evaluation with a 20 man trained panelist. From the preliminary work, sample D (sprouted for 96h) recorded ^{0}Brix and refractive index of 10 and 1347 respectively. The portions of sample D used in kunu production under continuous process at 55 and 40^{0}C (each for 120min i.e. 120_C) separately recorded TSS of 13 compared to 12 for counterpart sample (120_B) under the batch process The result of sensory evaluation also shows sample 120_C (processed at 40^{0}C) had the highest acceptability, suggesting significantly higher diastatic activity) conversion rate of the continuous process perhaps an indication of effectiveness of the device. Starch conversion, Therapeutic, Metabolism, Infant, and Aged.

KEYWORDS: TSS, solubility pH and spectrophotometry.

INTRODUCTION

'Tsiro' is the Hausa name for malted rice in Nigeria. It is a major ingredient in the preparation of a local beverage 'Kunun zaki'. Other ingredients required for the beverage production include a cereal base (sorghum, millet or maize), water, ginger and glove. The process of malting elaborates and activates enzymes (including alpha and beta amylases) in the germ area of the cotyledon of the cereal, enabling them to partially hydrolyze the starchy cotyledon, resulting to among other things, enhanced sweet taste and energy potentials of the kunun (Kolawole and Ayodele 2015). This approach to sweetening of beverages is more health friendly compared to use of refined (sucrose) table sugar (Akoma *et al* 2002). The development of technological knowhow or improvement on one already in use, for commercial production of this (more health friendly and relatively cheaper) therapeutic, will be helpful to the human society. The digestion as well as the metabolism enhancing or assisting capabilities of Tsiro and its remnants in food preparations can also be used to boast the therapeutic effects of other foods and food preparations. Research has revealed incidences of certain inherent metabolic disorders in (below fives) infants (www.webmd.com/a - z guides). At ages 40 and above, the rate of some of these activities begin to slow down (Akoma *et al* 2002, Nathan WS www.britainica.com/science/human aging). Enhanced local production, delivery and utilization of Tsiro based therapeutics, can provide the needed help for these categories of patience. This work, whose preliminary stage evaluated the impact of time (hours) of sprouting on the diastatic effects of paddy rice, attempted to evaluate 'kunu zaki' production process by means of continuous process (using the device designed and fabricated for this research) and the traditional batch process, with the aimed of achieving or encouraging large scale production of tsiro based beverages and perhaps therapeutic foods. Continuous processes create more room for enhanced hygiene and increased product outputs.

MATERIAL AND METHODS

Paddy rice grains were sprouted for 24 – 96h, spread on jute bag in a shed, at ambient temperature. On each (24h) day, 300g were collected and dried (under the sun) at 38± 2^0C resulting into samples A, B, C and D (slight modification of the traditional method). The diastatic activities (Total soluble solids – TSS, Refractive index, pH and water holding capacity) were measured by AOAC method (1980). Following the result of the preliminary work above and the research findings of Kolawole and Ayodele (2015), four portions (2g each) of sample D (sprouted for 96h) were weighed out and each added to separate 150ml of wet milled sorghum (at the point of loading of enzyme source) in the course of 'Kunu' production (**Figure** 2) according to the modified method of Ayo and Gaffa (2001). The portions were incubated at 50^0C for 60, 80, 100 and 120min. These (batch) experiments were repeated at 40, 45 and 55^0C. By making use of a (continuous macromolecule – starch conversion) device (**Figure** 1) designed and fabricated for this research, the experiment with portions of samples D as explained above were done all over. The Kunu samples (portions) from both batch and continuous operations were subjected to (TSS, Solubility and pH) tests, employing the AOAC method (1980); absorptivity test by the method of Hough (1991). The Kunu samples from continuous operation experiments were further subjected to sensory evaluation with 20 man trained panelist.

RESULTS AND DISCUSSIONS

From the preliminary work, the sample E (sprouted for 120h) produced the highest TSS (percent sugar) of 7.8. However, the research was continued with sample D (sprouted for 96h); the sample (**Table** 1) that produced the best 'kunu' (flavor and general acceptability) from 'maize flour distilled water mix', incubated as described. The better flavor observed might be a reflection of the pH of the converted (kunu) samples (**Table** 1). The pH for sample D is 4.7 while that of E is 4.0. This could have impacted a sour taste (flavor) on the product. In a similar work by Kolawole and Ayodele (2015), the alpha and beta amylase activity of sprouted cereals are usually at optimum on the 96h of germination. There is also a remarkable pattern in the moisture content (MC) and the water absorption capacity (WAC) of the sprouted samples. While the MC continued to decrease, the MAC increased from 24 t0 72h (**Table** 1). Perhaps the grains attained maximum moisture absorption (during soaking) before sprouting and declined thereafter because of perhaps denaturation of (protein) macromolecules. The portions of sample D used in kunu production under continuous process at 55 and 40^0C (each for 120min i.e. 120_C) separately recorded TSS of 13 compared to 12 for counterpart sample (120_B) under the batch process (**Table** 1). The result of sensory evaluation (**Table** 2) also shows sample 120_C (processed at 40^0C)had the highest acceptability, suggesting significantly higher (diastatic activity) conversion rate of the continuous process perhaps an indication of the capability of the device (continuous process) to enhance the activities of the converting (Alfa and Beta amylases) enzymes (Hough 1991). It is also important to note that the continuous device used in conversion, provided for deployment of the enzymes in partially immobilized forms (Hough 1991) during the operation (a remarkably cost saving step).

Table. I: Diastatic activities of malted rice, sprouted for various hrs.

Sample	Mc (%)	Water Absorption (g/ml)	PH	Diastatic Activity TSS	Diastatic Activity R/index
A	$9±0.04^a$	$16±1.34^a$	$5.9±0.03^a$	$4±0.96^a$	1338^a
B	$9±0.04^a$	$20±0.44^b$	$5.8±0.04^a$	$6±0.07^b$	1341^b
C	$9±0.26^a$	$20±0.44^b$	$5.7±0.00^a$	$6±0.07^b$	1341^b
D	$8.5±0.17^a$	$19±0.00^b$	$5.6±0.01^a$	$7±0.37^b$	1343^b
E	$8.5±0.17^a$	$20±0.44^b$	$5.5±0.08^a$	$7.8±0.73^c$	1344^c

Means ±SD with same superscripts are not significantly different ($p \leq 0.05$)

A- sprouted for 24hr, B- 48hr, C- 74hr, D- 96hr and E-120hr

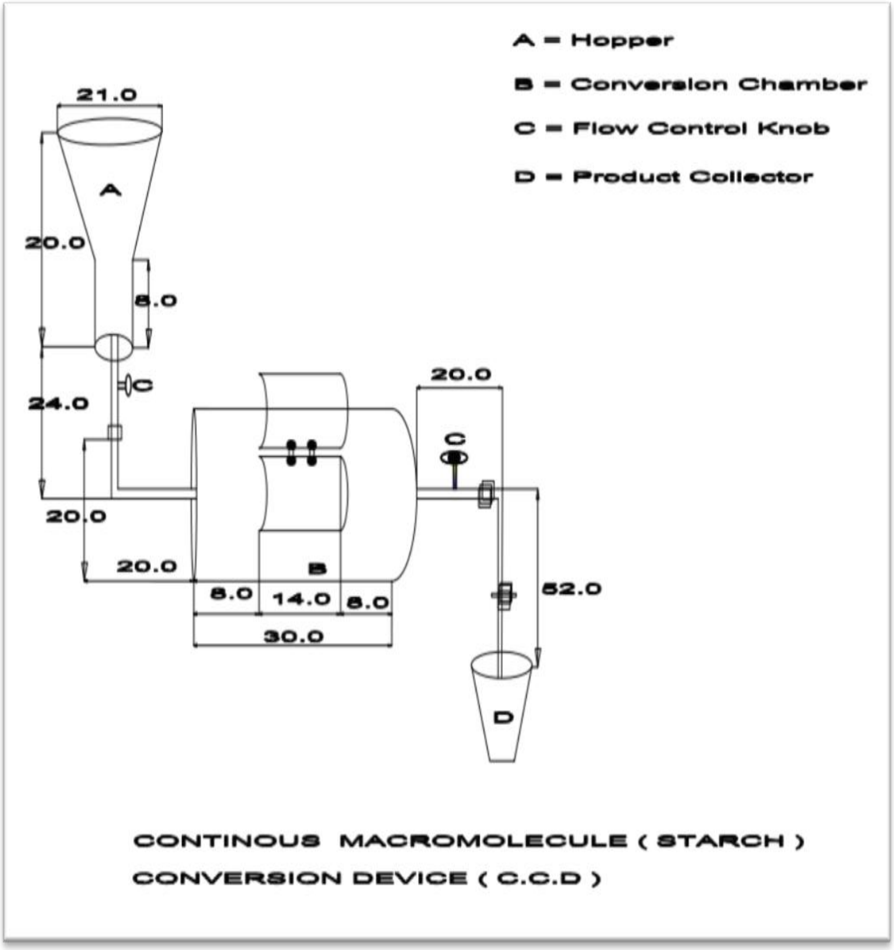
A = Hopper
B = Conversion Chamber
C = Flow Control Knob
D = Product Collector
21.0
20.0
8.0
24.0
20.0
20.0
8.0
14.0
8.0
30.0
20.0
52.0
A
B
C
C
D
CONTINOUS MACROMOLECULE (STARCH)
CONVERSION DEVICE (C.C.D)

Figure. 1.

Table II: Result of Exposure Time and Temp on Some Chemical (Diastatic) Parameters of Kunu Samples.

Time (min)	Absorptivity T1	Absorptivity T2	Absorptivity T3	Absorptivity T4	pH T1	pH T2	pH T3	pH T4	Solubility T1	Solubility T2	Solubility T3	Solubility T4	TSS T1	TSS T2	TSS T3	TSS T4
60$_B$	0.540±0.01^{a}	.480±0.03^{a}	.392±0.09^{a}	.492±0.08^{a}	4.3±0.09^{a}	4.2±0.20^{a}	4.3±0.29^{a}	4.0±0.04^{a}	59±0.9^{a}	60±1.1^{a}	70±0.5^{a}	60±081^{a}	8.3±0.10^{a}	9.0±0.10^{a}	7.4±0.77^{a}	9.0±0.19^{a}
60 $_C$	0.462±0.09^{a}	.396±0.09^{a}	.353±0.07^{a}	.459±0.07^{a}	4.1±0.20^{a}	4.4±0.11^{a}	4.3±0.21^{a}	4.0±0.05^{a}	59±1.2^{a}	70±0.8^{b}	59±0.8^{b}	69±0.8^{a}	9.5±0.14^{a}	10.0±0.91^{a}	9.5±0.07^{b}	10.5±0.11^{a}
80 $_B$	0.472±0.03^{a}	.471±0.03^{a}	.380±0.01^{a}	.380±0.04^{a}	4.1±0.21^{a}	4.0±0.14^{b}	4.2±0.19^{a}	4.0±0.15^{a}	60±0.9^{a}	65±0.7^{a}	79±0.6^{a}	75±0.1^{b}	9.0±0.13^{a}	9.9±0.18^{a}	8.2±0.73^{b}	10.0±0.81^{a}
80 $_C$	0.401±0.02^{a}	.370±0.10^{a}	.332±0.10^{b}	.343±0.03^{b}	4.1±0.11^{a}	4.3±0.15^{a}	4.2±0.88^{a}	3.8±0.06^{b}	60±0.1^{a}	85±1.2^{b}	65±0.4^{a}	75±1.0^{b}	10.0±0.13^{a}	10.5±0.80^{a}	10.5±0.19^{b}	11.0±0.25^{b}
100 $_B$	0.443±0.10^{a}	.443±0.10^{a}	.348±0.01^{b}	.372±0.02^{a}	4.0±0.22^{b}	4.0±0.14^{b}	4.0±0.17^{b}	3.8±0.07^{b}	69±0.3^{b}	79±0.2^{b}	85±0.3^{c}	89±0.9^{c}	11.0±0.02^{b}	10.5±0.18^{a}	9.9±0.90^{b}	11.5±0.43^{b}
100 $_C$	0.321±0.08^{b}	.364±0.04^{a}	.322±0.08^{b}	.335±0.05^{b}	4.0±0.34^{b}	4.3±0.18^{a}	3.8±0.07^{c}	3.6±0.17^{c}	65±0.3^{b}	90±0.4^{a}	89±0.2^{c}	95±0.8^{d}	11.5±0.52^{b}	10.8±0.88^{a}	11.0±0.88^{c}	12.5±0.70^{b}
120 $_B$	0.334±0.08^{b}	.333±0.04^{b}	.332±0.10^{b}	.370±0.05^{b}	4.0±0.22^{b}	4.0±0.16^{b}	4.0±0.18^{b}	3.8±0.08^{b}	70±0.8^{b}	80±0.4^{a}	95±1.0^{d}	97±0.7^{d}	12.0±0.09^{c}	11.0±0.18^{b}	11.0±0.18^{c}	12.0±0.43^{b}
120 $_C$	0.242±0.04^{c}	.261±0.03^{b}	.216±0.10^{c}	.321±0.06^{c}	4.0±0.20^{b}	4.2±0.15^{a}	3.5±0.07^{c}	3.5±0.18^{c}	79±0.1^{b}	92±0.1^{c}	95±0.9^{d}	99±0.6^{d}	13.0±0.41^{c}	11.2±0.72^{b}	12.0±0.96^{c}	13.0±0.39^{c}

Mean ±SD across column with same superscripts are not significantly different ($p \leq 0.05$)

T1 = 55^{0}C; T2 =50^{0}C; T3 =45^{O}C; T4 = 40^{0}C. TSS = Total soluble solids (sugar).

B= Batch process

C= Continuous process

Table III. Result of Sensory Evaluation of Kunu Samples From Continuous Processes (After 120 Minutes).

Sample	Taste	Consistency	Flavor	Colour	Genereal Acceptability
D_1	7.4±0.50^{b}	7.3±0.19^{b}	7.5±0.61^{c}	7.5±0.31^{b}	7.5±0.48^{b}
D_2	7.3±0.53^{b}	7.2±0.33^{b}	7.45±0.38^{bc}	7.4±0.35^{b}	7.4±0.56^{b}
D_3	7.4±0.61^{b}	7.4±0.21^{b}	7.5±0.44^{b}	7.4±0.59^{b}	7.65±0.44^{b}
D_4	8.3±0.69^{a}	8.4±0.27^{a}	8.3±0.14^{a}	8.4±0.10^{a}	8.4±0.39^{a}

Attributes with the same superscript, are not significantly different ($p \leq 0.05$)

D_1 at 55^{0}C

D_2 at 50^{0}C

D_3 at 45^{0}C

D_4 at 40^{0}C

Material (sorghum)

↓

Sorting

↓

Weighing (3000g)

↓

Washing

↓

Steeping (in water for 24 hour)

↓

Wet-milling (1500ml of water)

↓

Dilution (1:1.5)

↓

Loading of enzyme source

↓

Charging of machine with 30g of enzymes (tsiro)

↓

Feeding of the machine with sample through inlets

↓

Collection of kunu-zaki samples at (25,30,40,50,60,80,100 and 120minutes)

↓

Kunu-zaki

↓

Packaging

↓

Labeling

Fig. 2: Flow chart showing continuous method of kunu-zaki production.

Flow rate = output/time
= 1650ml/300
Flow rate=5.5ml/s

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