Investigative Study on the Influence of Some Selected Processing Parameters on Blending Efficiency and Drink Consistency Produced from a Grain Drinks Processing Machine

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ABSTRACT—*The effect of some selected processing parameters, grain variety and steeping duration on blending efficiency and consistency of drink produced from a Grain drink processing machine was studied. Three grain types of two varieties each for maize (Zea mays), guinea corn(Sorghum bicolor) were soaked for 12hours, 36 hours, 42 hours and soya beans (Glycine max) was soaked for 6 hours 12 hours and 16 hours in accordance to standard procedure (Gaffa et.al, 2003) then blended at a speed of 1300 r.p.m using horizontal-vertical blade assembly. The drinks from the grains were also extracted by centrifugal separation using the same machine and the blending efficiency and drink consistency were analyzed. The result obtained showed that dehulled white maize had the highest blending efficiency of 81.49% and consistency of 91.87 when soaked for 42 hours and blended for 600 seconds while soya beans 'B' had the least blending efficiency of 57.66% and consistency of 63.57% when soaked for 16 hours and blended for 600 second at constant blending speed of 1300 r.p.m. The development of this machine would solve the problem associated with the existing grains drink production and the demand of automated production of grain drinks in the food industry.*

Keywords—Blending efficiency, consistency, drink extraction, steeping duration and grain drink.

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1. INTRODUCTION

1.1 Background of the Study

Grain drinks are non-carbonated beverages that are specifically prepared for human consumption. Their non-alcoholic types such as *kunu* and its various type, soya milk and grain milk are generally accepted by both the Muslim and Christians in the northern Nigeria because of their non-alcoholic content (Abel *et. al.*, 2011). According to Bola and Aboaba, (2004) they are regarded as after meal drinks or refreshing drinks during the dry season in rural and urban centres, and also are used as weaning foods for infants at house hold and community level (Charles, 2008). The preparation of these beverages has become a common technology in many homes in the rural communities and more recently in the urban areas (Bola and Aboaba, 2004).

Basically, there are two major methods of grain drinks production; the traditional and the industrial method. The traditional method involves steeping of the grains, wet milling, wet sieving, cooking (optional) and addition of sugar. Ogiehor *et. al.*, (2005) reported that this method of grain drinks production is laborious, cumbersome and time consuming, while the industrial production method involves equipment which are sophisticated to operate and maintain by small and medium scale processors (Charles, 2008; Fayose 2008). Therefore the development of grain drink processing machine was undertaken in order to address some of the shortcomings associated with these two methods of grain drinks production. To combine the unit operations of grain drink production which involve blending of soaked grains, mixing of the slurry and drink extraction in a single unit and also to efficiently process grains into hygienic drinks capable of meeting all safety and environmental criteria. Further, more to produce equipment that can easily be replicated by the local fabricators easily operated and maintain by local processors as this will increased production and utilization. Thus, this paper is a presentation of a study on the effect of processing parameters on blending efficiency and consistency of grains drink produced from a machine that was developed at the Agricultural and Bioresources Engineering Department of the Federal University of Technology Minna, Nigeria.

2. MATERIALS AND METHODS

2.1 Machine Description

The machine was made from stainless steel materials. It was designed in order to carry out the major operations of blending of the soaked grains, mixing the slurry with water and extraction of the drink all in a single unit. The major component of the machine include blending blades, water holding tank, rotary perforated drum assembly and power unit. The blending operation is achieved by disengaging the perforated drum from rotation while the central shaft is in motion while the separation operation is achieved by allowing the perforated drum to rotate together with the central shaft as shown in Fig 1a & 1b.

Fig 1a: Fabricated Grains Drink Processing Machine

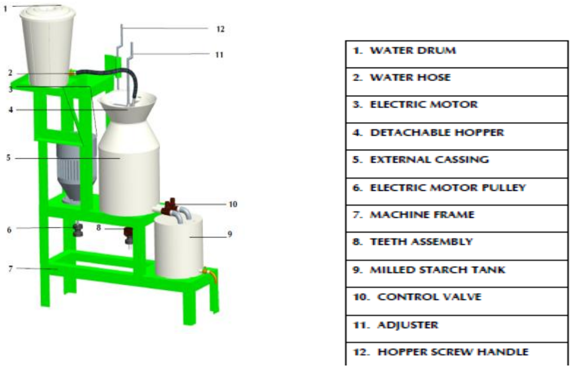

Fig 1b: Autocad Drawing of the Fabricated Machine

2.2 Material Preparations

The materials used are two varieties each of maize (white maize and yellow maize), sorghum (white guinea corn and red guinea corn) and soya bean (large seeded and small seeded). These materials were obtained from Minna main market in Niger state, Nigeria. About 27 kg of each of these grains were sorted and cleaned. The maize and sorghum samples were soaked with 6 litres of water at room temperature for a conventionally accepted recommended duration of 24hours, 36 hours and 42 hours (Gaffa *et. al.,* 2003;) while those of soya beans were soaked in the same quantity of water at room temperature for 6 hours, 12 hours and 16 hours.

2.3 Experimental Procedure

The soaked grains were blended in the machine using horizontal and vertical blade assembly. During the blending operation 4 litres of water was intermittently added to the grains in order to accelerate the blending operation. Each of the slurry was sieved with 21 liters of water in order to thoroughly wash the milled starch from the milk and was allowed to settle down for 15 hours. The water was decanted and the starch and residue were dried to the initial moisture contents of their respective grains. The dried starch and residue were weighed using weighing machine. The percentage loss, blending efficiency and consistency were then computed using the formula below and the results are presented in Table 1-3.

2.3.1 Percentage Loss

$$L_s = \frac{\text{A} - (\text{M} + \text{R})}{A} \text{X } 100 \qquad (1)$$

Where L_s is percentage loss
A is initial weight of the grains
M is weight of milled starch (dried to the same moisture content with A)
R is weight of dry residue (dried to the same moisture content with A)

2.3.2 The Blending Efficiency

$$E_B = \frac{\text{M}}{A} \text{X } 100 \qquad (2)$$

Where E_B is the blending efficiency
M is dry weight of milled starch/milk (dried to the same moisture content with A)
A is initial weight of grain

2.3.3 Consistency

$$E_C = \frac{M}{A^1} X\, 100 \qquad (3)$$

Where E_C is the consistency of grain drink
M is dry weight of milled starch/milk
A^1 is proximate composition of edible part of the grain
For white maize (88.7% of A) = 2661

Yellow maize (90% of A) = 2700
Soya beans (90.7% of A) = 2721
Sorghum (90.5% of A) = 2715 (`Peping *et., al,* 1988)

3. RESULTS AND DISCUSSION

3.1 Results

The results of the experiment are presented in Table 1 to 3

Table 1:Blending Efficiency and Drink Consistency Values of the Machine when 3000g each of Various Grain Types Soaked for **First Steeping Duration** of 6 hrs for Soya Beans and 24 hrs each for Maize and Guinea Corn were Soaked for 24.

S/N	Type of Grains	Steeping Duration (hrs)	Weight of Dry Residue (g)	Ave. Weight of Dry Residue (g)	Weight of Mill Starch (g)	Ave. Weight of Mill Starch (g)	% Loss	Blending Efficiency (%)	Consistency (%)
1	Soya beans 'A'	6	1182.5 1190.4 1210.33	1194.41	1629.05 1621.18 1601.2	1617.14	6.28	48.51	59.43
2	Soya beans 'B'	6	1223.66 1287.45 1246.75	1252.62	1580.74 1516.9 1557.48	1551.71	6.52	46.55	57.03
3	Dehulled white maize	24	782.5 815.12 803.48	800.37	2213.6 2180.9 2192.37	2195.62	0.13	65.87	82.51
4	Dehulled yellow maize	24	1443.12 1483.2 1480.7	1469.01	1552.23 1512.28 1514.73	1526.45	0.15	45.79	50.88
5	White Guinea corn	24	1063.52 1085.43 1080.13	1076.36	1931 1908.2 1914.56	1917.92	0.18	55.02	67.56
6	Red Guinea corn	24	1182.81 1146.23 1152.12	1160.39	1811.7 1848.32 1842.4	1834.14	0.18	55.02	67.56

Table 2:Blending Efficiency and Drink Consistency Values of the Machine when 3000g each of Various Grain Types Soaked for **Second Steeping Duration** of 12 hrs for Soya Beans and 24 hrs each for Maize and Guinea Corn were Soaked for 36.

S/N	Type of Grains	Steeping Duration (hrs)	Weight of Dry Residue (g)	Ave. Weight of Dry Residue (g)	Weight of Mill Starch/ Milk (g)	Ave. Weight of Mill Starch/ Milk (g)	% Loss	Blending Efficiency (%)	Consistency (%)
1			1024.49		1773.18				
	Soya beans 'A'	12	1019.4	1019.74	1778.27	1777.93	6.74	59	65.34
			1015.33		1782.34				
			1080.4		1717.33				
2	Soya beans 'B'	12	1091	1086.4	1706.73	1711.33	6.74	57.04	62.89
			1087.8		1709.93				
			644.4		2351.18				
3	Dehulled white maize	36	648.1	646.23	2347.38	2349.23	0.15	78.23	88.28
			646.3		2349.13				
			1170.3		1825.11				
4	Dehulled yellow maize	36	1173.4	1177.24	1822.01	1818.17	0.15	60.61	67.34
			1188.02		1807.39				
			890.2		2104.37				
5	White Guinea corn	36	883.33	882.4	2111.24	2112.17	0.181	70	77.8
			873.07		2120.9				
			976.32		2014.23				
6	Red Guinea corn	36	980	976.38	2024.57	2018.17	0.18	67.27	81.7
			972.82		2015.73				

Table 3:Blending Efficiency and Drink Consistency Values of the Machine when 3000g each of Various Grain Types Soaked for **Third Steeping Duration** of 16 hrs for Soya Beans and 24 hrs each for Maize and Guinea Corn were Soaked for 42.

S/N	Type of Grainsc	Steeping Duration (hrs)	Weight of Dry Residue (g)	Ave. Weight of Dry Residue (g)	Weight of Mill Starch/Milk (g)	Ave. Weight of Mill Starch/Milk (g)	% Loss	Blending Efficiency (%)	Consistency (%)
1			1019.6		1780.4				
	Soya beans 'A'	16	1012.7	10127	1784.8	1784.8	6.75	59.4	65.59
1			1006.3		1789.2				
			1084.3		1710.5				
2	Soya beans 'B'	16	1066.6	1066.6	1729.7	1729.7	6.79	57.66	63.57
			1050.4		1748.9				
			574.62		2622.8				
3	Dehulled white maize	42	553.02	554.02	2642.6	2444.6	0.15	81.49	91.87
			531.5		2466.4				
4	Dehull		1172.3	1164.1	1825.7	1834.1	0.06	61.14	67.93

	ed yellow maize	42	1162.1		1833.1					
			1155.9		1842.5					
			570.6		2400.5					
5	White Guine a corn	42	572.87	572.87	2425.6	2425.6	0.17	80.85	89.34	
			547.63		2450.7					
			683.3		2315.3					
6	Red Guine a corn	42	632.5	635.5	2363	2363	0.05	78.77	87.03	
			687.7		2310.7					

3.2 Discussion

3.2.1 Effect of Grain Variety on Blending Efficiency

The effect of grain variety on blending efficiency for various grains is presented in tables 1-3. Dehulled white maize had the highest blending efficiency of 78.23% while soya beans 'B' had lowest blending efficiency of 57.66% when samples of maize and sorghum were soaked for 36 hours and soya beans for 12 hours and then blended with horizontal-vertical blade assembly at constant blending time of 600 seconds and blending speed of 1300 r.p.m.(Table 2) The high blending efficiency of dehulled white maize could be as a result of dehulling of its seed which breaks the seeds due to the fact that it is more brittle compared to the other seeds, thus facilitating blending. The lower quantity of dry starch/milk powder of soya bean 'B' which result to its low blending efficiency could be as result of high viscosity of its slurry which decreases the rate of its blending, its insoluble flocculent protein content which decrease its sedimentation and its low starch content compared with the other grains under this study. This observation seems to conform with the result of an earlier study (Thava 2001) where the insoluble flocculent protein content of legume seeds are found to decrease sedimentation of starch and also co-settle with starch to give a brownish deposit. It was also observed that yellow maize requires longer steeping time due to hardness of its seed kernel while soya beans requires less steeping time due to softness of its seed kernel.

3.2.2 Effects of grain variety on dry weight of milled starch/milk and drink consistency

The quantity of milled starch/milk is a direct index of the consistency of the grain drink. The effect of grain variety on consistency for samples of maize, sorghum and beans is presented in Table 2. Dehulled white maize had the highest quantity of dry weight of milled starch of 2349.23g and highest consistency of 88.28%, while soya beans 'B' had the least quantity of dry weight of 1711.33g milled starch/milk and corresponding lowest consistency of 63.57% at a blending speed of 1300 r.p.m and blending time of 600 seconds. The milled starch production and drink consistency was observed to be higher for dehulled white maize compared with other grains. Soya beans 'B' recorded the least milled starch/milk production with corresponding lowest consistency

3.2.3 The Effect of Steeping Duration on Blending Efficiency

The effect of steeping duration on blending efficiency of the various grains is presented in table 1 to 3. Steeping dehulled white maize for 42hours produced the highest blending efficiency of 81.49% while steeping dehulled yellow maize for 24hours produced the lowest blending efficiency of 42.79%.All the grains produced their highest blending efficiency (57.66% - 81.49%) at highest steeping duration of 42hours for maize, sorghum and 16 hours for soya beans, while the least blending efficiency range of 45.79% to 65.87% was obtained at lowest steeping duration of 24 hours and 6 hours for maize and soya beans respectively. For dehulled white maize there was significant difference in blending efficiency between steeping duration of 24 hours (65.87%) and steeping duration of 36 hours (78.23%), but there was no significant difference in blending efficiency between steeping duration of 36hours (78.23%) and 42hours (81.49%). This observation is the same for all the other grains.

3.2.4 The Effect of Steeping Duration on dry weight of milled starch/milk and drink consistency

The effect of steeping duration on dry weight of milled starch/ milk and drink consistency is presented in table 1 to 3. Steeping dehulled white maize for 42hours produced the highest dry quantity of milled starch of 2622 kg while steeping soya bean B (small seeded) produced the lowest dry quantity of milk powder of 1551.71 kg when soaked for 6 hours. All the grains under this study have their highest dry weight of milled starch/ milk (2349.23 kg to 1711.33 kg) at highest steeping duration of 42 hours for maize and 16 hours for soya beans, while the least dry weight of milled starch/ milk range between 2195.62 kg to 1551.71 kg were obtained at lowest steeping duration of 24 hours for maize and 6 hours for soya beans. It was also observed from table 1 to 3 that dehulled white maize produced the highest drink consistency of 91.87% when soaked for 42 hours and soya beans B (small seeded) produced the least drink consistency of 57.03% when soaked for 6 hours. Also it was observed that the drinks consistency increase with increase in quantity of milled starch/ milk and also with increase in steeping duration For dehulled white maize there is no significant difference in drink consistency between steeping duration of 36 hours (88.28%) and 42 hours (91.87%), but there is significant difference between steeping duration of 24 hours (82.51%) and 36 hours (88.28%). This is the same for all the grains under this study.

4. CONCLUSIONS

The test on the machine was concluded. The results obtained were discussed and the following conclusions were made.

1. Both machine blending efficiency and drink consistency were found to increase with increase in steeping duration. The highest blending efficiency for all the grains range from 57.66% (soya beans 'B') to 81.49% (dehulled white maize) at blending speed of 1300 r.p.m for 600 secs using horizontal-vertical blades assembly.
2. The highest machine blending efficiency and drink consistency of 81.49% and 91.87% were recorded by blending white maize (soaked for 42 hours) while the least values of 45.79% blending efficiency and 50.88% consistency were observed by blending yellow maize (soaked for 24 hours).
3. The highest dry quantity of milled starch of 2622 kg was obtained by blending white maize (soaked for 42 hours) while the least quantity of dry milk powder of1551.71 kg was obtained from soya beans B (soaked for 6 hours).
4. Dehulled white maize was observed to produce the highest blending efficiency, white guinea corn was also found to perform better than red guinea corn and large seeded soya beans 'A' perform better than smaller seeded soya beans 'B'.
5. Soya beans requires less steeping time due to softness of its seed kernel while yellow maize requires more steeping time due to hardness of its seed kernel.

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