Influence of Blending time on the Efficiency and Milk Consistency of a Grains Drink Processing Machine

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Influence of Blending time on the Efficiency and Milk Consistency of a Grains Drink Processing Machine

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***Abstract*— The influence of blending time on blending efficiency and consistency of drink produced from grains drink processing machine developed at the Agricultural and Bio-resources Engineering Department of the Federal University of Technology, Minna, Nigeria was studied. Two varieties each of maize, soybean and red guinea corn were blended for 720, 600, 420 and 300 seconds using vertical-horizontal blade assemblies. The results obtained showed that blending white maize for 720 seconds recorded the highest blending efficiency of 78.45% and drink consistency of 89.57%, while blending yellow maize for 300 seconds had the least blending efficiency of 30.63% and consistency of 34.04%.**

***Keywords:* Blending efficiency, blending time, drink consistency, grains drink, processing.**

I. INTRODUCTION

Grains undergo series of processing steps using different equipment in order to produce milled starch or milk for drink production. The basic steps in grains drink production include cleaning, steeping, wet milling; wet sieving, mixing and cooking [1]. Wet sieving (sieving in water) or the separation of fine from the coarse portion in an aqueous medium (water) is an indispensable primary process that is used to extract biopolymers from cereal grains. Also it is used in extracting milk from soy beans, a very important rich source of protein for the general populace. The process which is carried out manually using drums, pots, filter cloth (muslin cloth) and mesh is energy and time consuming, tedious and back straining [2].

Milled starch is one of the components obtained from wet milling of grains which is used for grains drink production. The starch in grains drink is a biopolymer glucose which is the major storage component of most economically important crops: cereal (e.g. wheat, rice, corn, sorghum and oat) and legumes (e.g. beans and pea.) [3]. It breaks down in the digestive tract into simpler and more easily digested sugar to supply the body with its primary source of energy. It also exists as water insoluble granule, generally ranging in size between 3 and 6 μm [3].

The process of wet sieving allows for the washing of starch granules and milk from other particles like fibres and hulls especially in processing both cereal grains and various mechanical systems for separating or sieving agricultural products have been developed. Earle and Earle, [4] indicated that industrial sieves such as rotary screens, horizontal cylinders either perforated or covered with a screen into which the material is fed are being used in separation processes in food industries. The smaller particles pass through as they tumble around in the rotating screens. Other industrial sieves are vibrating screens which are generally actuated by an eccentric weight, and multi-deck screens on which the particles fall through from one screen to another of decreasing apertures, until they reach one which is too fine for them to pass. The separation efficiency of the vibrating screens system is affected by the frequency and amplitude of the vibrations.

Although a lot of work has been done locally to mechanize the milling and sieving of dry agricultural products, it is however observed that no extensive work has been done locally to mechanize and combine the milling and sieving of wet agricultural products in a single unit for small scale and home use basis. Thus, the development of a grains drink processing machine was undertaken to efficiently process grains into hygienic drink. This paper therefore reports the influence of grains blending time on blending efficiency and consistency of grain drink processing machine developed at the Agricultural & Bio-resources Engineering Department of The Federal University of Technology Minna, Nigeria.

II. MATERIALS AND METHODS

A. *Materials Preparation*

Two varieties each of Maize (white maize and yellow maize), sorghum (white guinea corn and yellow guinea corn) and soybean (large seeded and small seeded) grains were obtained from Mina main market in Niger State, Nigeria. From each variety, 3000g of each of these grains were sorted and cleaned. The maize and sorghum samples were soaked in 6 litres of water at room temperature for a conventionally accepted recommended duration of 36 hours [5], while those of soybeans were soaked in the same quantity of water at room temperature for 12 hours [6].

B. *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 seed, mixing the blend materials with water extraction of the drink in a single unit.

The major components of the machine include blending units, 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 plates I&II.

Plate I. Fabricated Grains drink processing machine

Plate II. Soybean milk during processing

C. *Experimental Procedure*

The soaked samples of 3000g each of two varieties of maize (white maize and yellow maize), guinea corn (white guinea corn and red guinea corn) and soybean (large seeded and small seeded) were blended for a period of 5, 7, 10 and 12 minutes at a speed of 1300 r.p.m using Horizontal-Vertical blades assembly [7]. Blade design was found to have the most significant effect on the apparent size distribution of process materials (lactose) [8-10]. Rotation speed also matters and usually has an optimum value. At too low a speed, there is inadequate agitation; but at low speeds, avalanching flow can occur, which is efficient in mixing. At too high a speed, centrifugal force sends all the particles to the perimeter [11].

Three litres of water was added intermittently during the blending operation due to the high viscosity, flocculent protein content and stickiness characteristics of the grains. Each of the slurry was sieved with 1:7 liters of water in order to thoroughly wash the milled starch from the milk as shown in plate III. [1].

Plate III: Milled starch after processing

In order to obtain dry quantities of starch and residue, the starch was allowed to settle down for 14hrs and the liquid fraction of the slurry was decanted and the starch and residue were sun dried to 10% moisture contents of as shown in plate IV.

Plate IV: Residue from red guinea corn

The dried starch and residue were weighed using spring weighing machine and the percentage loss, blending efficiency and consistency were then obtained using equations 1-3 below. The results are shown as presented in tables 1-3 and figs 1&2.

i) Percentage Losses: $L_S = \frac{A-(M+R)}{A} X100$ ...1

Where Ls = percentage losses

A = initial weight of the grains (g)

M = weight of milled starch (g)

R = weight of dry residue (g)

ii) Blending Efficiency: $E_B = \frac{M}{A} X100$ 2

Where E_B = the blending efficiency (%)

M = dry weight of milled starch/milk (g)

A = initial weight of the grains (g)

iii) Consistency efficiency: $E_C = \frac{M}{A^1} X100$ 3

Where EC = consistency efficiency (%)

M = dry weight of milled starch/milk (g)

A^1 = proximate composition of edible part of the grains.

For white maize (88.7% of A) = 2661

Yellow maize (90% of A) =2700

Soy bean (90.7% of A) = 2721

Sorghum (90.5% of A) = 2715

III. RESULTS AND DISCUSSION

A. The Influence of Blending Time on Consistency

The influence of blending time on consistency of the drink using vertical horizontal blade using a processing speed of 1300rpm for various grains is presented in tables 1-3. Blending dehulled white maize for 720 seconds recorded the highest drink consistency of 89.57% while the least consistency of 34.04% was recorded for dehulled yellow maize when blended for 300 secs as shown in Fig 1.

Generally, the highest consistency ranged between 62.99%-89.57% for all grain varieties was obtained from blending the grains for 720 secs. The least consistency range of 34.04%-51.43% was obtained from blending for 300 secs. This observation is in line with the result of an earlier study carried out by Jayesh, [12] where consistency of drink was found to be affected by the degree of impact resulting from repeated effect of the hammers and volume of the material loaded into the blender. However, it was observed that there was a significant difference in consistency between blending for 300 secs (45.42%) and blending for 420 secs (68.31%), but there was no significant difference in consistency between blending for 600 secs (88.28%) and blending for 720 secs (89.37%) for all the grains.

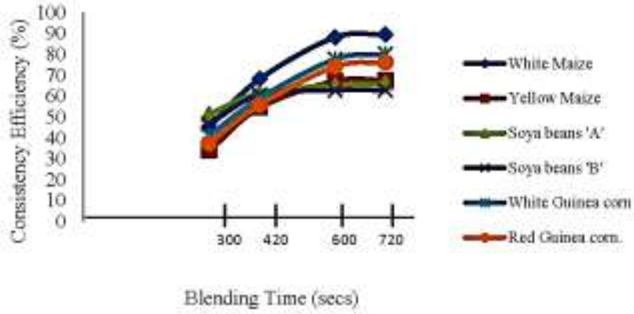

Fig 1: Relationship between Blending Time and drink consistency at constant Blending Speed of 1300 r.p.m using vertical-horizontal blade Assembly.

B. The Influence of Blending Time on Blending Efficiency.

The Influence of blending time on blending efficiency for various grains is presented in tables 1-3. In general, the highest blending efficiency ranged between 57.14%-78.45% were obtained from blending the grains for 720 secs and the least blending efficiency range between 30.63%-46.65% were obtained from blending for 300 secs for all grains.

Specifically, blending dehulled white maize for 720 secs recorded the highest blending efficiency of 78.45%, while blending the same dehulled white maize for 300 secs recorded lower blending efficiency of 40.29% as shown in fig 2. Also, blending dehulled yellow maize for 300 secs recorded the least blending efficiency of 30.04% at a speed of 1300 r.p.m using vertical-horizontal blade assembly.

Also, a significant difference in blending efficiency of dehulled white maize between blending durations of 300 secs (40.29%) and 420 secs (60.60%) were obtained, but there was no significant difference in blending efficiency between blending time for 600 secs (78.23%) and 720 secs (78.45%). This was same for all the grains.

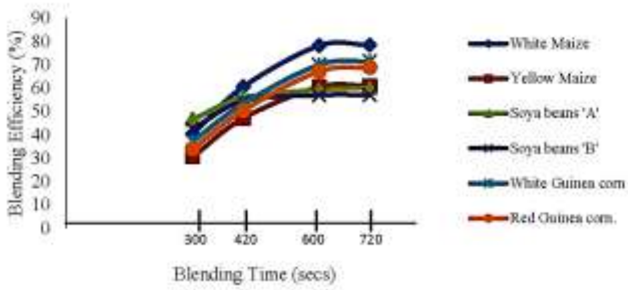

Fig 2: Relationship between Blending Time and Blending Efficiency at constant Blending Speed of 1300 r.p.m using vertical-horizontal blade Assembly.

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TABLE I

RESULT OF INFLUENCE OF TIME ON CONSISTENCY AND BLENDING EFFICIENCY FOR MAIZE

S/NO	Type of Grain	Time of Blending (Secs)	Weight of Dry Residue	Ave. Weight of Dry Residue	Weight of Milled Starch/Milk (g)	Ave. Weight of Milled Starch/Milk (g)	Percentage Loss (%)	Blending Efficiency (%)	Consistency Efficiency (%)
1	Dehulled		605.00		2390.50				
	White	720	584.23	612.11	2411.64	2383.50	0.14	78.45	89.97
	Maize		647.10		2348.36				
			644.30		2351.18				
		600	648.10	646.23	2347.38	2349.23	0.15	78.23	88.28
			646.35		2349.13				
			1170.30		1827.36				
		420	1180.40	1179.86	1817.26	1817.80	0.078	60.60	68.31
			1188.88		1808.78				
			1700.65		1193.71				
		300	1780.30	1790.30	1198.81	1208.66	0.035	40.29	45.42
			1790.00		1233.46				
2	Dehulled		1131.95		1854.55				
	Yellow	720	1155.10	1157.27	1828.40	1829.40	0.43	60.98	67.76
	Maize		1184.75		1805.25				
	(poporn)		1115.30		1825.11				
		600	1118.10	1177.24	1822.01	1896.27	0.48	60.61	67.34
			1101.80		1807.39				
			1530.20		1467.34				
		420	1520.35	1523.44	1477.39	1474.39	0.072	49.14	54.60
			1519.57		1478.17				
			2075.20		923.78				
		300	2080.50	2080.01	918.48	918.97	0.034	30.63	34.04
			2084.33		914.65				

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TABLE II

RESULT OF INFLUENCE OF TIME ON CONSISTENCY AND BLENDING EFFICIENCY FOR SOY BEAN

S/No	Type of Grain	Time of Blending (Secs)	Weight of Dry Residue (g)	Ave. Weight of Dry Residue (g)	Weight of Milled Starch/Milk (g)	Ave. Weight of Milled Starch/Milk (g)	Percentage Loss (%)	Blending Efficiency (%)	Consistency Efficiency (%)
3	Soy Bean 'A'	720	996.02 981.25 1076.52	1017.93	1823.42 1829.50 1747.88	1803.60	5.88	60.12	66.28
		600	1024.49 1019.40 1015.33	1019.74	1773.18 1798.27 1782.34	1777.93	6.74	59.26	65.34
		420	1104.00 1196.10 1066.99	1122.37	1695.40 1603.30 1732.41	1677.03	6.69	55.90	61.63
		300	1403.33 1400.76 1394.32	1399.47	1395.59 1398.19 1404.63	1399.87	6.7	46.65	51.43
4	Soy Bean 'B'	720	1082.10 1109.20 1123.05	1104.78	1735.42 1710.20 1696.98	1714.20	5.97	57.14	62.99
		600	1286.40 1291.00 1287.80	1086.40	1717.33 1700.73 1709.93	1711.33	6.74	57.04	62.89
		420	1169.42 1173.76 1154.16	1165.78	1630.01 1625.70 1645.30	1633.67	6.68	54.46	60.63
		300	1515.54 1530.15 1519.83	1521.84	1276.56 1270.71 1281.03	1276.10	6.70	42.64	46.90

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TABLE III

RESULT OF INFLUENCE OF TIME ON CONSISTENCY AND BLENDING EFFICIENCY FOR GUINEA CORN

S/No	Type of Grain	Time of Blending (Secs)	Weight of Dry Residue (g)	Ave. Weight of Dry Residue (g)	Weight of Milled Starch/Milk (g)	Ave. Weight of Milled Starch/Milk (g)	Loss (%)	Blending Efficiency (%)	Consistency Efficiency (%)
5	White Guinea Corn	720	830.10 813.25 825.10	822.81	2165.40 2182.45 2170.45	2172.76	0.146	71.58	80.20
		600	890.20 883.33 873.67	882.40	2104.37 2111.24 2120.90	2112.17	0.181	70.00	77.80
		420	1400.30 1393.39 1389.99	1394.56	1596.49 1599.39 1607.51	1601.13	0.41	53.32	58.97
		300	1875.40 1877.80 1888.99	1880.73	1123.26 1120.86 1109.67	1117.93	0.05	37.23	41.18
6	Red Guinea Corn	720	994.23 896.39 882.41	924.34	1995.23 2098.14 2112.13	2068.50	0.236	68.95	76.19
		600	980.32 970.00 978.82	976.38	2014.23 2024.57 2015.73	2018.17	0.18	67.21	74.33
		420	1480.55 1485.81 1481.56	1482.64	1516.28 1510.83 1515.08	1514.97	0.08	50.45	55.80
		300	1977.36 1980.42 1973.43	1977.07	1021.28 1018.22 1025.21	1021.57	0.045	34.02	37.63

IV. Conclusions

The results obtained from the study on the influence of blending time on blending efficiency and milk consistency have been discussed. The machine blending efficiency was found to be 78.45% when dehulled white maize (soaked for 36 hours) was processed at blending speed of 1300 r.p.m for 720 and 600 seconds using horizontal-vertical blade assembly. Blending for 720 secs produced the highest value of grain drink consistency of 89.4% using the same blending speed of 1300rpm and horizontal-vertical dehulling blade. Since there was no significant difference in the performance of the machine in terms of the values obtained for drink consistency and blending efficiency at blending durations of 720 secs and 600 secs, optimum blending time of 600 secs was selected for blending all the grains at blending speed of 1300 r.p.m with vertical-horizontal blade assembly. The residue obtained from processing the grains was also found to be useful for animal feed formulations due to the ability of the machine to be adjusted to produce residues of different sizes (coarse, medium and fine) for animal consumption.

V. References

[1] I. M. Gana, "Development and Testing of Grains Drink Processing Machine," Unpublished Thesis for the Award of Masters Degree in the Department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna, Nigeria, 2011.

[2] F. Fayose, "The Development of a Multi Purpose Wet Food Sieving Machine," Agricultural Engineering International: CIGR Journal, 2009.

[3] V. Thava, "Overview of laboratory isolation of starch from plant material," www.nshtvn.org/../fac020/pdf. accessed 21 March 2011, 2001.

[4] R. L. Earle and M. D. Earle, "Unit operation in food processing. www.nzifst.org.nz/unitoperation, accessed 20th April, 2010," 1983.

[5] T. Gaffa, I. Jideani, and I. Nkama, "Traditional production, consumption and storage of Kunu–a non alcoholic cereal beverage," Plant Foods for Human Nutrition (Formerly Qualitas Plantarum), vol. 57, pp. 73-81, 2002.

[6] www.en/wiki/soybean, accessed 10th May, 2010, 2010.

[7] A. Gbabo, I.M. Gana, and S.M. Dauda, "Effect of blade types on the blending efficiency and milk consistency of a grains drink processing machine," Academic Research International, vol. 2, pp. 41-49, 2012.

[8] R. Bridson, P. T Robbins, Y. Chen, D. Westerman, C. R. Gillham, T. C. Roche, and J. P. K. Seville, "The effects of high shear blending on α-lactose monohydrate," International journal of pharmaceutics, vol. 339, pp. 84-90, 2007.

[9] A. Gbabo, I.M. Gana, and S.M. Dauda, "Effect of blending speed on efficiency and consistency of a grains drink processing machine," International Journal of Agronomy and Agricultural Research, vol. 2, pp. 1-6, 2012.

[10] D. H. Wagner, S. Ramanathan, M. L. Taylor, A.B. Brown, M. E. Staben Wobker, and M. W. Prior, "The thermodynamics of high shear blending," Powder Technology, vol. 193, pp. 195-199, 2009.

[11] J. P. Clark, "Dry Mixing: Case Studies in Food Engineering. In: J. Peter Clark (Editor)," Food Engineering Series. Springer New York, pp. 5-15, 2009.

[12] T. Jayesh, "V-Blenders," http://www.brighthubengineering.com/manufacturing-technology/53250-v-blender-construction-operation-and-application/, Lamar Stonecypher eds, accessed 13th August 2012, 2009.