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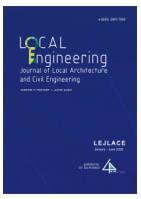

Architecture – Research Article

Effect of Time and Speed on the Performance of a Machine for Mixing Groundnuts Seeds with Additives

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A B S T R A C T

Studies that investigated the effectiveness of groundnut mixing as a function of mixing speed and time are scarcely reported. Therefore, the objective of the study is to investigate the main and interaction effects between additive and speed on the mixing evaluation parameters, with respect to different mixing proportions of ginger, wheat flour and pepper. The mixing parameters for evaluating the mixer are; degree of mixing, percentage loss and mixing efficiency. The components of the mixer consist of the frame, the U-shaped trough, a central shaft and a helical ribbon agitator. The coating unit consists of coating trough, drive shaft and electric motor. The highest values of the degree of mixing and mixing efficiency recorded were 92.23 and 99.75% respectively. The efficiency of mixing increases as mixing time increases. Similarly, increased performance in mixing was observed as the mixing speed increases. The main and interaction effects between the additive and speed were insignificant ($P > 0.05$). The highest speed of 60 rpm and mixing time of 15 mins produced the highest mixing efficiency.

INTRODUCTION

Groundnut (Arachis hypogaea L.) also known as peanut, earthnut and ground bean is a leguminous oilseed crop cultivated in the semi-arid and subtropical regions of the world (FAOSTAT, 2014). Groundnut has a rich nutty flavor, sweet taste, crunchy texture and over and above a relatively longer shelf life. It is an important crop in many countries, especially in Sub-Sahara Africa, where it is a good source of protein (25%-34%), cooking oil (48%-50%) and vitamins. The haulms are a good source of feed for livestock, especially during the dry season when fresh green grasses are not available.

In Nigeria, the processing of groundnut into various products is mostly done by women either for home consumption or for commercial purposes but without value addition (Ajeigbe et al. 2015). Absence of value addition in the supply value - chain with Nigeria focusing mostly on food production and neglecting the processing and manufacturing thereby losing opportunities for higher earnings and ability to generate employment. Food processing enables the year- round availability of foods that have limited growing seasons (Oluwamukomi, 2021); and this include groundnut and many other crops. The processing of groundnut includes various unit operations such as decorticating, cleaning, roasting, mixing with additives, coating and packaging. Mixing, coating and roasting constitute important aspects in the food industry that enhance rapid production in the processing industry.

Mixing is the combination of two or more elements of particles of different components and combining them into a homogeneous additive (Peeranat et al. 2021). The particles are homogenized when shaken or vibrated (Behnke 2005). Mixing in the food industry is used mainly to obtain homogeneity with the best possible equipment and the best relation of the power correlations.

Edible films and coatings also play an important role in the quality, safety, transportation, storage and display of a wide range of fresh and processed foods. Food coating is an innovation within biodegradable active packaging concept, which interacts with food to extend shelf life and improve safety and/or functional or sensory properties while maintaining the quality of food packaging. Edible films and coatings based on biopolymers have taken a major boom in the food industry owing to many factors such as biodegradability characteristics that contribute to reducing environmental pollution, and their potential to prevent the alteration in food mainly preserving physical, chemical and sensory properties. Before mixing, the groundnut mixing components must be thoroughly mixed, which is a function of mixing speed and time. Therefore, the main objective of this study is to evaluate effect of various machine speeds and time on mixing parameters for groundnut mixing with additives, using a developed groundnut mixing machine.

Design considerations and Description of the Mixer

The groundnut processing machine was conceived to reduce the cost of mixing, coating and roasting in groundnut processing, alleviate drudgery, time consumption in coating groundnut and attract people into the processing operation. One of the factors considered in the design of the processing plant was the cost of the mixing, coating and roasting groundnut that was made affordable by using locally available materials without compromising its effectiveness. The processing plant was designed in a manner that the mode of operation was made easy for the operators with minimum training and the components of the processing plant were easy to fabricate, assemble and maintain. With these considerations, the processing plant should be able to:

a. mix a substantial amount of the additives with the provision of hopper;
b. discharge the additives through the provision of outlet at the base of the mixer;
c. mix the additives in a short time without wastage of ingredients;
d. corrosion resistance of the various component parts of the machine
e. aesthetic and conform to safety regulations

Description of Ribbon Mixer

The machine employed in the mixing unit is a ribbon mixer. Ribbon mixers are principally used for homogenous mixing of two or more powder materials with no or minimum possible wet essential solutions. Ribbon mixers are designed for mixing wide variety of materials with widely varying densities at high mixing efficiency in a remarkable short time. The machine consists of a horizontal U-shaped trough containing a central shaft and a helical ribbon agitator. Two counteracting ribbons are mounted on the same shaft, one moving the solid slowly in one direction, the other moving it quickly in other direction. Mixing results from the turbulence induced by the counteracting agitators, not from mere motion of solids through the trough. The ribbon mixer operates on batch - wise with the solids charged and mixed until satisfactory. The whole assembly is fitted on rigid frame structure. The trough is located through the opening at the top. Bottom discharge spouts are also provided. The exploded view is shown in figure 1.

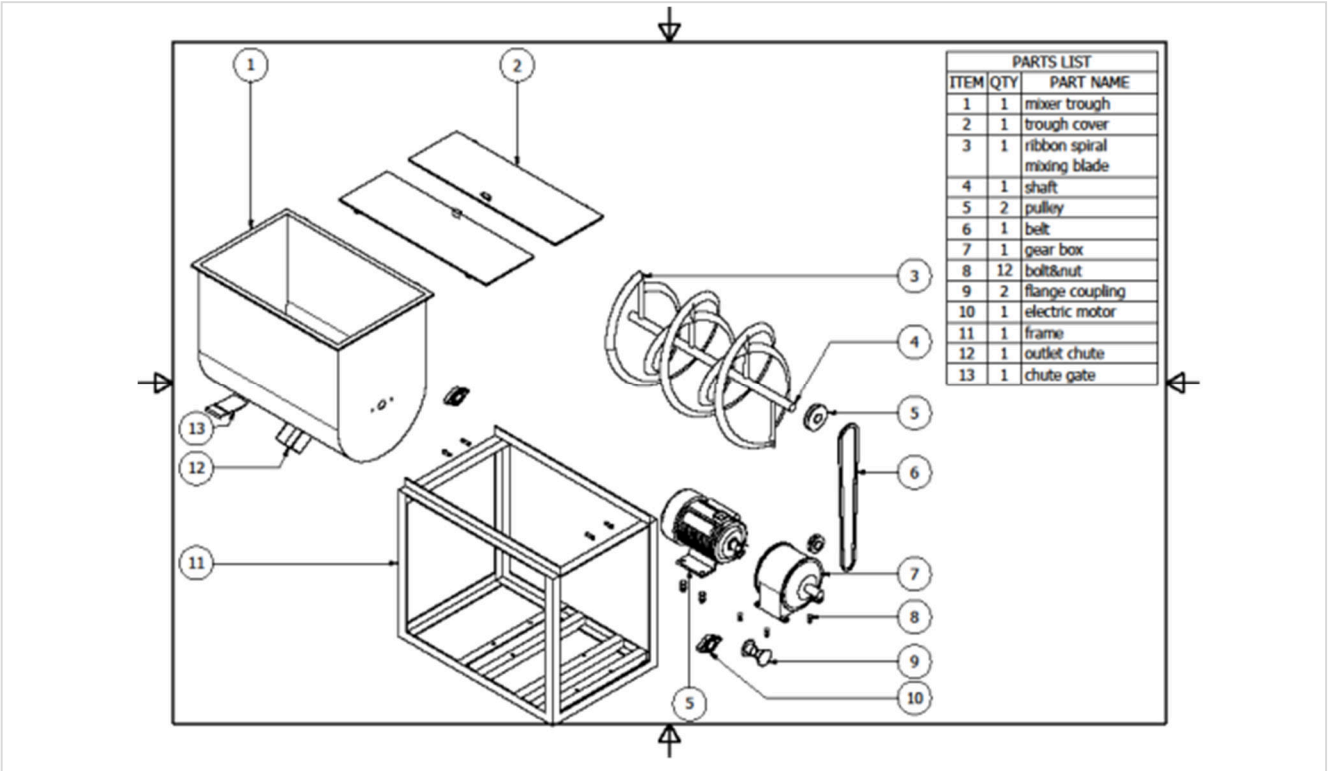

Figure 1: The exploded view of the Ribbon Mixing machine

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RESULTS AND DISCUSSION

Mixing of groundnut seed coating ingredient

The effects of the mixing speed on the mixing time, final mass and losses of additives A, B and C are given in tables 1-3.

Table 1: Influence of speed and different mixture on the mixing parameters for additive

Additve	Speed (rpm)	Mixing time(min)	Final mass(g)	Losses(g)
A	40	5	996.99a	3.01a
A	50	5	995.50a	4.50b
A	60	5	997.19a	2.81ab
A	40	10	996.35a	3.65a
A	50	10	996.28a	3.72a
A	60	10	996.55a	3.45a
A	40	15	996.46a	3.54a
A	50	15	997.58a	2.42b
A	60	15	998.36a	1.64c
Main effects				
Speed		NS	NS	NS
Wheat flour		NS	NS	NS
Ginger		NS	NS	NS
Interaction effects		NS	NS	NS
Speed*Wheat flour		NS	NS	NS
Speed ginger		NS	NS	NS

Note: Additive A consisted of 930, 25, 25 and 20g of wheat flour, ginger, pepper

Table 2: Influence of speed and different mixtures on the mixing parameters for additive B

Additive	Speed (rpm)	Mixing time(min)	Final mass(g)	Losses(g)
B	40	5	998.12a	1.88a
B	50	5	995.50a	4.17b
B	60	5	997.88a	2.12ab
B	40	10	997.21a	2.79ab
B	50	10	996.28a	3.72a
B	60	10	996.82a	3.18b
B	40	15	998.00a	2.00a
B	50	15	996.48a	3.52b
B	60	15	997.74a	2.26a
Main effects				
Speed		NS	NS	NS
Wheat flour		NS	NS	NS
Ginger		NS	NS	NS
Interaction effects		NS	NS	NS
Speed*Wheat flour		NS	NS	NS
Speed ginger		NS	NS	NS

Note: The additive B consisted of 945, 20, 20 and 15g

Table 3: Influence of speed and different mixtures on the mixing parameters for additive C

Additive	Speed (rpm)	Mixing time(min)	Final mass(g)	Losses(g)
C	40	5	995.48a	4.52a
C	50	5	995.81a	4.19a
C	60	5	997.19a	2.81b
C	40	10	997.42a	2.58a
C	50	10	998.48a	1.52b
C	60	10	998.22a	1.78b
C	40	15	997.12a	2.88a
C	50	15	997.45a	2.55a
C	60	15	998.36a	2.03b
Main effects				
Speed		NS	NS	NS
Wheat flour		NS	NS	NS
Ginger		NS	NS	NS
Interaction effects		NS	NS	NS
Speed*Wheat flour		NS	NS	NS
Speed ginger		NS	NS	NS

Note: Additive C consisted of 955, 20, 15 and 10g for wheat flour, ginger, pepper and salt, respectively

Additive A consisted of 930, 25, 25 and 20g of wheat flour, ginger, pepper. The additive B consisted of 945, 20, 20 and 15g while the additive C consisted of 955, 20, 15 and 10g for wheat flour, ginger, pepper and salt, respectively. The total mass of the additive total 1000g. In all treatments, no obvious effect of mixing speed was observed on the mixing time. The effect was insignificant ($P > 0.05$) on the mixing time, final mass and the amount of the additive losses. However, the result of the analysis showed that mixing time reduces as the mixing speed increases. The lowest mixing time was achieved at a speed of 60 rpm. Also, the mass of losses mostly reduced as the mixing speed increased. The main effect of all the mixing components and speed were all insignificant ($P > 0.05$) on the mixing time, final mass and losses.

Table 4: Performance of groundnut seed mixer

Mixing Time(min)	Coefficient of variation (%)	Degree of mixing (%)	Percentage loss (%)	Mixer efficiency (%)
5	13.75	85.17b	34.57a	99.62a
10	13.60	86.76b	36.21a	99.64a
15	8.94	92.23a	25.33b	99.75a
speed(rpm)				
40	15.6	84.40a	44a	99.56a
50	13.64	86.36a	36ab	99.65a
60	10.86	89.14a	25b	99.75a

CONCLUSION

On the present work, a machine for mixing groundnut seeds with additives for value addition was designed, fabricated and the performance evaluation was carried out. Different proportions of ginger, wheat flour, salt and pepper were considered in the mixtures. From the research, mixing parameters like mixing speed and the different additive components do not affect the mixing evaluation parameters. Also, the machine evaluation showed that the degree of mixing and mixing efficiency was high.

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