DESIGN, FABRICATION AND EVALUATION OF A CORN ROASTER

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ABSTRACT

In Nigeria, roasted maize is one of the most popular and available snacks readily available on the street. It's cheap, easy to eat, it has a calling aroma and also tasty on the taste bud. Its crudes processing is such that starchy matured corn are harvested, dehulled and placed on a metal grill under which fired charcoal is placed to generate heat for the roasting and hand fan is used to blow air which support combustion a process which is strenuous and unhealthy. A corn roaster was designed, fabricated and evaluated in other to improve on existing corn roasting process by improving product hygiene, increase through-put and reduce roasting drudgery faced by roasted corn vendors through the incorporation of a cylindrical corn holder which eradicate vendor's contact with the produce throughout roasting process, incorporation of a hand operated blower to improve supply of air to the charcoal as source of heat and the incorporation of a canopy support which holds umbrella for the vendor. In order to evaluate the roaster, effective air distribution test within the charcoal tray was carried out so as to know the efficiency of the hand operated blower. For the effective air distribution test, a know mass of charcoal was blown continuously using the incorporated blower and the existing traditional methods, time taken to ignite 100% charcoal in both test were found to be 45 and 35minutes respectively. For through-put, 15 pieces of corn were roasted, time taken to complete roasting was observed to be 15minutes for fabricated roaster and 20 minutes for existing traditional method respectively. Effect of continuous and discontinuous blowing on roasting time and percentage burnt was established and found to be Two (2) to two (2) minutes thirty seconds with 22% burnt and three (3) to three (3) minutes twenty seconds with 17% burnt for continuous and discontinuous blowing respectively.

KEYWORDS: Corn, Roaster, Blower, Heat, Hygiene, Throughput

INTRODUCTION

Processing of food items has becomes an important aspect of human daily practices and nearly all the food consumed by humans are processed in some way such as milling, frying, boiling roasting etc.

The method of application of heat for food processing is most prominent in Nigeria. It is also common in urban household and among rural dwellers, who themselves through farming take roasting as an important food processing technique. Food processing is defined as the practices used by food and beverage industries to

transform raw plant and animal materials into products for consumption. Roasting is a process by which the food product is subjected to thermal and irreversible structural changes accompanied by reduction of moisture contents purposely to enhance digestible content for human consumption (Fellows, 2000). Roasting can also be described as a process in which a product basically agricultural product is subjected to dry heat either in oven or over fire in other to remove moisture and also cook the product so as to become edible.

Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice, however, little of this maize is consumed directly by humans: most are used for corn ethanol, animal feed and other maize products, such as corn starch and corn syrup (Foley, J. 2019). Sweet corn which is rich in sugar is grown for consumption by human as kernels. In. It season is always anticipated by most Nigerians due to the above mentioned characteristics. Its crudes processing is such that starchy matured corn are harvested, dehulled and placed on a metal grill under which fired charcoal is placed to generate heat for the roasting and hand fan is used to blow air which support combustion. The faster the hand fan blows, the faster the air current, the faster the rate of combustion and the rate of heat transfer from the charcoal to the maize The process becomes strenuous as the operator tired out with time before the maize is completely roasted. (The corn roast is almost like popcorn except the eruption). The corn pops as it roasts and begins to turn a golden yellow & black colour. There are no utensils used in this cooking method. The vendor uses his/her bare hands to pick up the scorching cob and even to rearrange the burning cods, a practice that is not hygienic and discomforting. Also, direct contact and exposure of the human body to heat emitted from the charcoal may have side effect on the human skin.

In view of the aforementioned bottle necks associated with existing corn roasting method, a corn roaster was designed and fabricated to improve hygiene and discomfort associated with roasting process.

MATERIALS AND METHODS

An uncomplicated machine which can simply be manually operated was design, fabricated and evaluated for roasting corn. While fabricating the designed machine, the following objectives were held paramount: improved hygiene in roasting process, appropriateness for corn roasting, ease of operation and maintenance of the machine, low operational cost and energy efficiency. The fabricated roaster consists of the following components: i.) Frame ii) cylindrical corn holder iii) blower iv) charcoal tray v) ash collector vi) Canopy Support

Frame: An angle bar (L shaped iron bar) made from mild steel was used for it construct. It is rectangular in shape having a dimension of 500 x 500 x 750mm. 4mm gauge angle iron bar was used for the frame.

Cylindrical Corn Holder: Cylindrical bars made from stainless steel were used for the construction of this member. Five (5) strands (each having 5mm Dia.) of cylindrical stainless steel bar were welded round a circular flat plate also made from stainless steel to form the housing in which corn to be roasted sits throughout roasting process. Also attached to the cylindrical housing is a wooden handle which serves as insulator and also as turner during roasting process. The length and diameter of this

member are 450mm and 80mm Dia. respectively.

Blower: A hand operated blower usually used by goldsmith was sourced for since the machine must be affordable then local content is of the essence. The blower is made using wood, thick cloth and air tightened using tube strands and nails. The wind generated is channeled onto the charcoal tray using a hallowed pipe with 4mm thickness.

Charcoal Tray: It is a rectangular member made from mild steel. It is of dimension 420 x 450 mm. The charcoal tray is perforated to ensure that ash do not accumulate on it. Also round the perimeter of the tray is welded a 50mm upright flat plate to prevent charcoal from falling off the tray. The tray is also incorporated a handle for ease of loading and unloading of charcoal.

Ash Collector: It is a rectangular member also made from mild steel and usually located under the charcoal tray. It serves as a receptacle for ash from already burnt charcoal. It is of dimension 420 x 450mm. It is also incorporated with a handle for removing the collected ash.

Canopy Support: A hollow pipe made from mild steel was welded to the frame of the machine to hold umbrella while roasting in other to prevent operator from direct sun impact since vendors usually roast in open space especially road side.

DESIGN CONSIDERATION

BLOWER : Blower was incorporated into the assembly to reduce human drudgery and also to increase the rate at which the charcoal burns thereby increasing roasting time per batch.

Corn Holder: Corn roster serves two main purposes in this design. it replaces the usage of a metal grill that typically will span across the length of the charcoal tray there by reducing the cost of production of the roaster. More so, it reduces human contact with the corn as the corn will simply be rotated within the holder leading to a safer finished product due to the measure taken.

Wheel: The incorporation of the wheel in this assembly enables easy movement of the equipment from one place to the other in case of relocation of the owner.

DESIGN CALCULATION

The frame of the machine was designed to accommodate charcoal tray, ashtray, blower, canopy support and cylindrical corn holder.

$V_0 = L_0 \times B_0 \times T_0$ (Olayinka, O.A., 2017)

Where V_0, L_0, B_0, and T_0 respectively represents the total volume of the angle iron (mm^3), length of the angle iron (mm), breadth of the angle iron (mm) and the thickness of the angle iron (mm).

Total volume of stainless

$V_0 = \pi r^2 h$ (Olayinka, O.A., 2017)

Where V_0, r and h respectively represent the total volume of stainless steel (mm^3), radius of each stainless strand and height of the stainless.

Total mass of stainless steel used was calculated using the formula below

$M = \rho v$ (Olayinka, O.A., 2017)

Where M, ρ and v are mass, density and volume of the different steel.

PERFORMANCE EVALUATION

In order to evaluate the fabricated roaster, effective air distribution test within the charcoal tray was carried out and roaster throughput was also determined. For the effective air distribution test, charcoal of known mass of 64.82g was ignited and blown continuously using the incorporated blower until 100% of the charcoal was fully ignited. Percentage charcoal ignited was recorded against time. As for the roasting throughput, the cylindrical corn roaster holder was loaded after 100% charcoal was

fully ignited. The blower was operated continuously during roasting and numbers of roasted corn was recorded per time. . The results obtained from the two tests were compared with result obtained using existing method of roasting corn.

Percentage of roasted kernels:

$P_r = \frac{p1+p2+p3+p4}{4}$ (Kerthik, S.K. et.al., 2017)

Percentage of roasted kernels (P_r) of the fabricated roaster was obtained by taking the mean value of percentages of each trial where p1, p2,p3and p4 are percentages of roasted kernels in first, second, third and forth corn housing (cylindrical corn holder) respectively.

$P_1 - P_4 = \frac{Roasted\ kernels}{Total\ kernels}\ 100$ (Kerthik, S.K. et.al., 2017)

Percentage of over roasted kernels (P_0)

$$P_0 = \frac{p_{01}+ P_{02}+ P_{03}+ P_{04}}{4}$$

Where, P_{01}, P_{02}, P_{03} and P_{04} are percentage of over roasted kernels in the first, second, third and forth corn housing (cylindrical corn holder) respectively.

$$P_{01} - P_{04} = \frac{Over\ roasted\ kernels}{Total\ kernels}\ 100$$

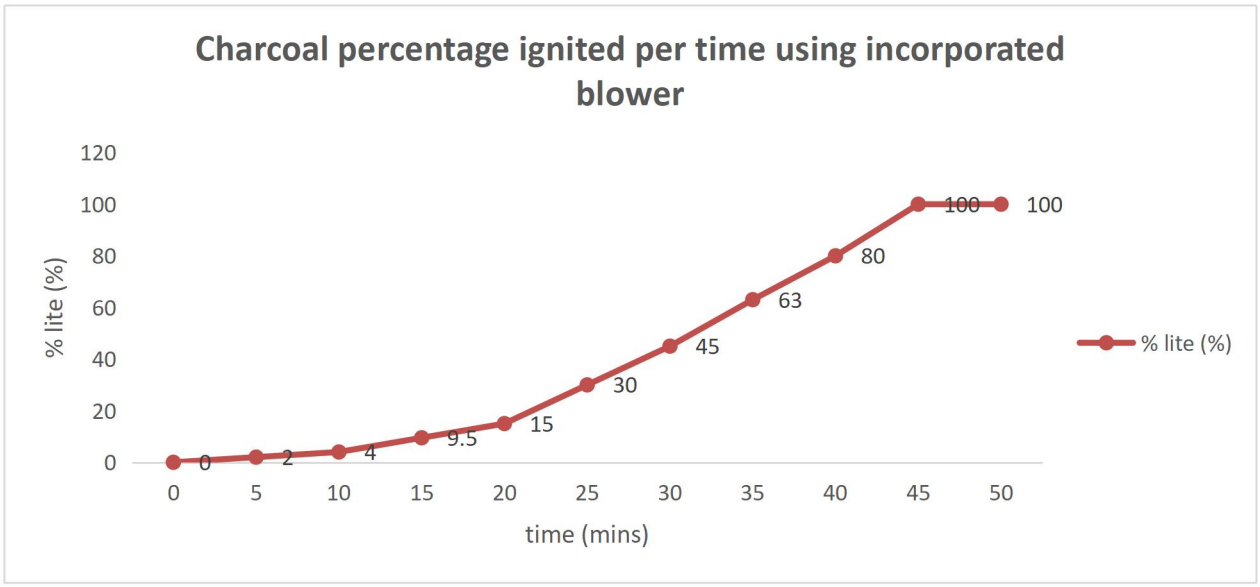
Roasting capacity (R_c):

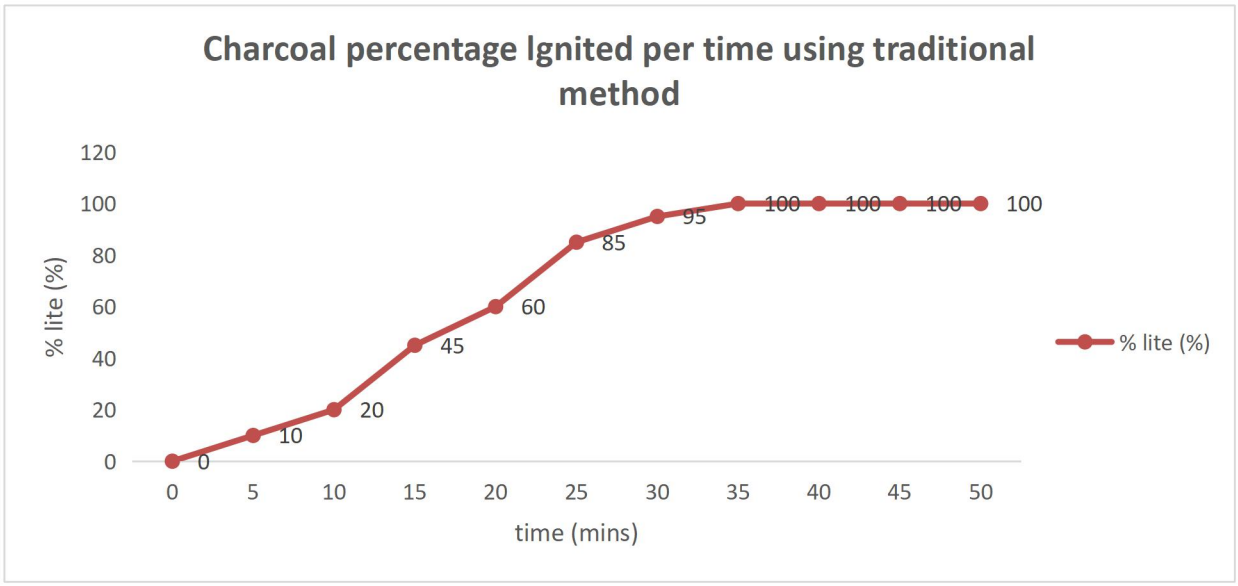
Roasting capacity was obtained per batch and was calculated using the formula below

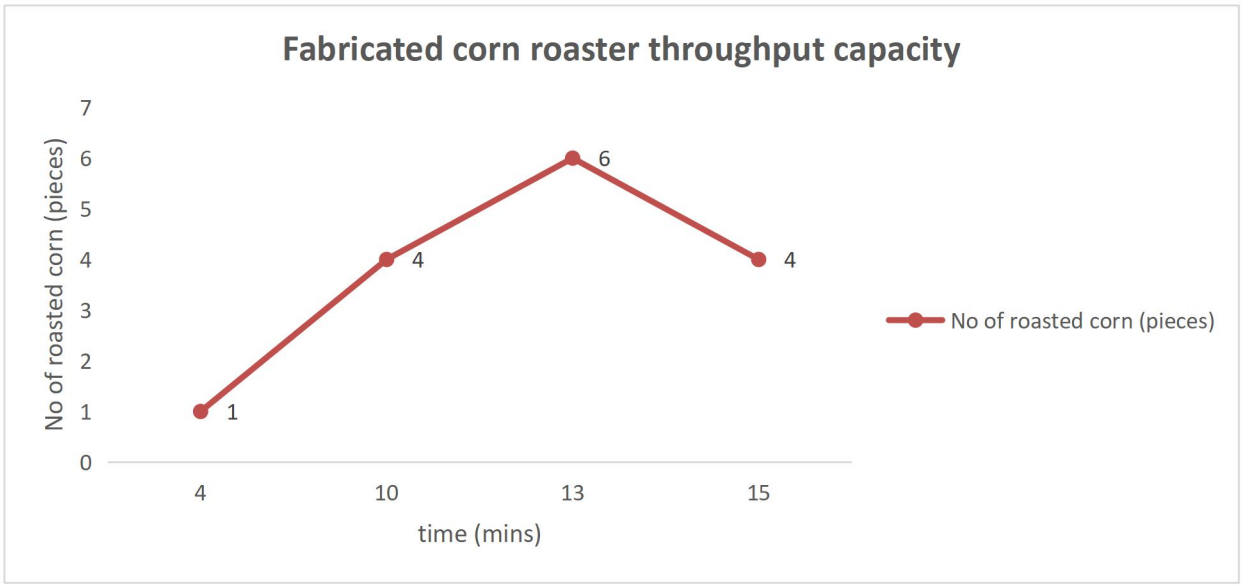
$$R_c = \frac{Number\ of\ corn\ roasted}{time\ taken\ to\ roast\ corn\ (Sec)}$$

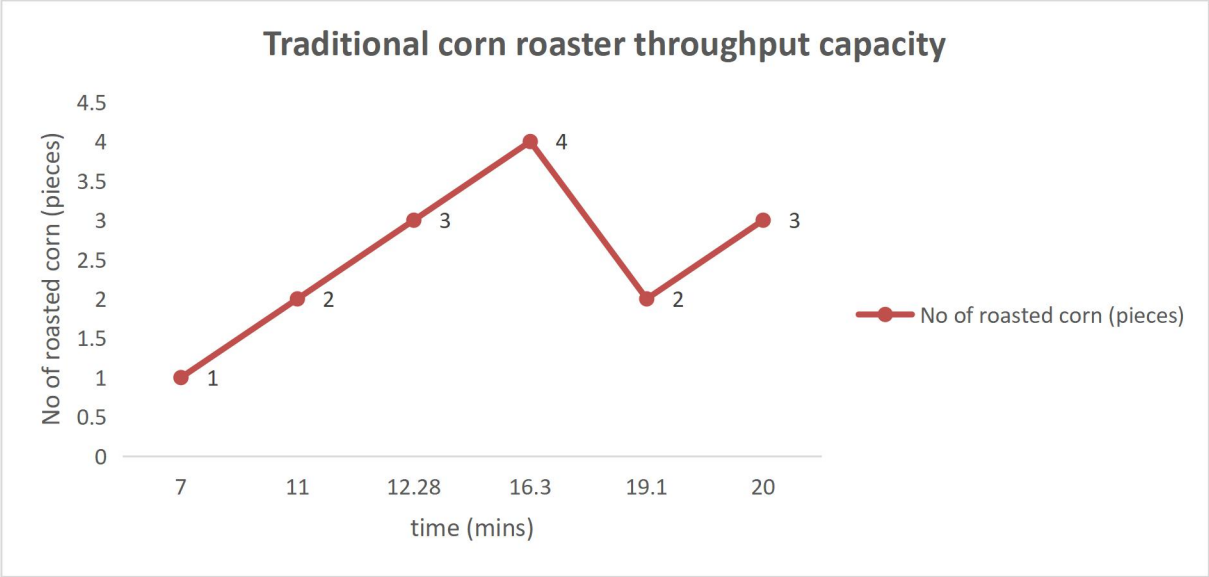
RESULT AND CONCLUSION

Results obtained from the effective air distribution test and roaster throughput for the fabricated roaster and the traditional method of roasting corn are presented graphically below.




Charcoal percentage lgnited per time using traditional method
120
100
80
60
40
20
0
% lite (%)
0
10
20
45
60
85
95
100
100
100
100
100
0
5
10
15
20
25
30
35
40
45
50
time (mins)
% lite (%)


Fabricated corn roaster throughput capacity
7
6
5
4
3
2
1
0
No of roasted corn (pieces)
1
4
6
4
4
10
13
15
time (mins)
No of roasted corn (pieces)



Effects of continuous blowing on roasting time and over roasting percentage

In order to know the effect of continuous blowing on time and over roasting percentage, 3 corns were roasted, number of the kernels on the 3 cobs were counted and average number was recorded to be 420 kernels. After continuous blowing, an average of 95 out of 420 kernels were burnt while the remaining were satisfactory for consumptions.

It also took an average time of 120-150 seconds for roasting to be completed. When compared to discontinuous blowing, 72 out of 420 kernels were burnt while roasting time was recorded to be in the range of 180-200 seconds.

CONCLUSION

The following conclusions were made:

I. From the result obtain, the fabricated roasting machine performed better than the existing corn roasting method when compared using roasting time.
II. The fabricated roaster is far more hygienic than existing traditional roasting method through the incorporated of a cylindrical corn holder which prevent vendor's contact with the roasted corn
III. It was noticed that maize located at the central of the roaster roast faster than those not centrally located which is because the pipe that supplies air to the charcoal tray passes through the central there by increasing the air pressure within the region which in turns burns charcoal faster leading to increase in heat generation in the zone.
IV. The fabricated corn roaster conveniently accommodated 15 pieces of corn per batch and an average roasting time was recorded to be 15min

RECOMMENDATION

The following recommendations are made for further studies.

I. The blower stand should be made rigid to avoid movement of the roaster when operational.
II. Charcoal preheating should not be done using the incorporated blower as it takes longer time to ignite all charcoal within the tray
III. Continuous blowing using the incorporated blower should be avoided to minimize percentage burnt kernels
IV. Charcoal located at the center of the tray should be mixed frequently with those located in other parts of the tray to reduce percentage burnt kernels
V. Thickness of the pipe channeling air to the charcoal should be increases to avoid frequent replacement which will lead to increase maintenance cost.

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