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PERFORMANCE EVALUATION OF AN ONION PRESERVATIVE MACHINE

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ABSTRACT

An onion preservative machine was developed (designed and fabricated) that is capable of preserving onions in large tonnage for a period of three to six months, which will take care of challenges posed in preserving onions. Thus, dealing with inflation and scarcity of onions after harvest period and helping in availability of quality onions round the year. The procedure employed includes the design, construction and testing stages. Components of the machine are cabinet with perforated trays, blower with motor, heaters, base with rollers, duct, and control unit which houses temperature controller, contactor, switch, and thermocouple.

Keyword: Onion, tonne, inflation, scarcity, quality, machine

1.0 INTRODUCTION

Onion known scientifically as Allium cepa is a perishable vegetable used for cooking. It is a vegetable which belongs to the Family of Liliaceae; plant found mainly in the temperate region. In other languages, it is called Ayim (Ibibio), Ayo (Igbo), Alubosa (Yoruba), and Albasa (Hausa). Musa and Mukhtar (2015) reported the antioxidant abilities of onions in arresting free radicals which cause gastric

ulceration. Also, Musa and Mukhtar (2015) reported that onions have hypoglycaemic, antihypertensive and anticonvulsant property. Most onions contain vitamin C, vitamin B6, folic acid and other numerous nutrients in small amounts. They are low in fats and in sodium, having an energy value of 166kJ (40 kcal) per 100g (3.5 oz) serving, they can contribute their flavour to savoury sssdishes without raising caloric content appreciably (Musa and Mukhtar, 2015).

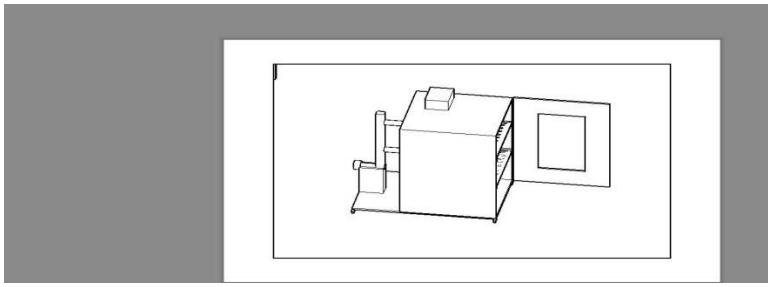
2.0 LITREATURE REVIEW

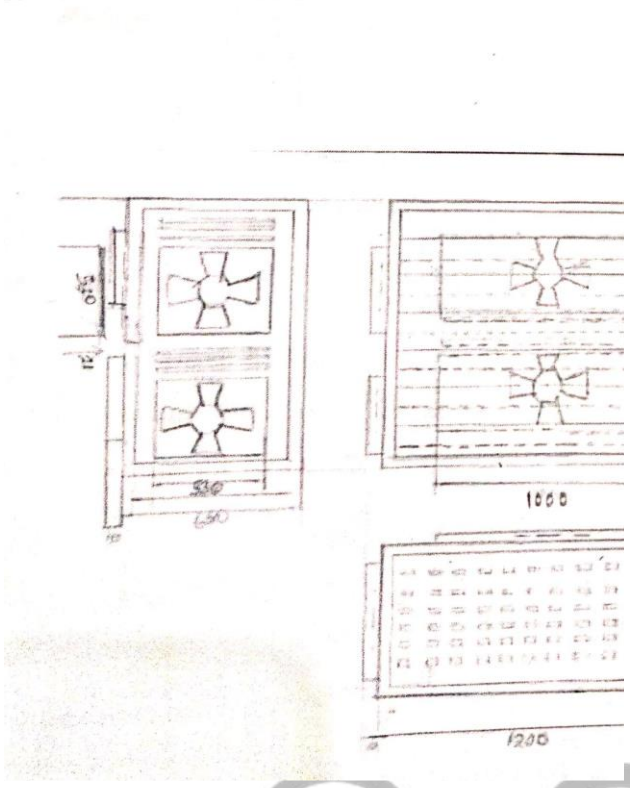
There are considerable differences between different varieties in potential antioxidant content. Shallots have the highest level, six times the amount found in Vidalia onions, the variety with the smallest amount (Yang et al, 2004).Some people suffer from allergic reactions after handling onions, and other symptoms can include contact dermatitis, intense itching, rhino conjunctivitis, blurred vision, bronchial asthma, sweating and anaphylaxis (Arochena *et al*., 2012). There may be no allergic reaction in these individuals to the consumption of onions, perhaps because of the denaturing of the proteins involved during the cooking process (Arochena *et al*., 2012).

Onion is best dried at temperature between 25°C and 31°C (Onion-potato, 2018)

3.0 METHODS

The methodology in this context comprises the onion storag
factors such as control of temperature, insulations of the machine, humidity, ventilation, and onions composition. Humidity level for onion preservation should be kept between 65-70%





3.1 Isometric and exploded view of the machine

3.2 ONION STORAGE TEMPERATURES

It should be noted that Onions can be stored at two ranges of temperatures.

1. Between 0°C and 4°C and this is known as the cold storage.
2. Between 25°C and 31°C it is referred to as the heat storage.

3.3 DESIGN ANALYSIS

3.3.1 Newton's Law of Cooling

Mathematically, Newton's law of cooling was determined by using equation (1) as given by (Engineering Toolbox, 2003).

$$q = h_c A dt \quad \text{----------(1)}$$

Where,

q = Heat transferred per unit time

h_c= Convective heat transfer coefficient

A = Area of the surface

dt = Temperature difference

Convective heat transfer of the process (h_c) was determined by using equation (2) as given by (Khurmi and Gupta, 2012).

$$h_c = 1.022(t_{d2} - t_{d1}) \quad \text{----------(2)}$$

Where,

t_{d1} = Temperature of air before reaching the heater rods

t_{d2} = Temperature of air leaving the heater rods

Given, t_{d1} = 27^0C, t_{d2} = 29^0C (from measurement)

h_c = 1.022(29-27)

h_c = 2.044W/mK

Area of the surface (A) was determined by using equation (3) as given by (Engineering Toolbox, 2003).

$A = Length \times breadth$----------

--------- (3)

Given, length = 0.61m, breadth = 0.61m

A = 0.61 x 0.61

A = 0.3721m^2

From equation (1), recall $q = h_c A dt$

Given, h_c = 2.044W/mK and A = 0.3721m^2(from calculation), dt = (160-29) = 131^0C

$q = 2.044 \times 0.3721 \times 131$

$q = 99.6W$

3.3.2 Fourier's Law of Conduction

Mathematically, Fourier's law is expressed and was determined by using equation (4) as given by (Engineering Toolbox, 2003).

$q = (K/S)AdT$ ----------

----------(4)

Where,

K = Thermal conductivity of material

S = Material thickness

A = heat transfer area

q = Heat transfer

dT = $t_1 - t_2$

= temperature of air at the heater rod – temperature inside the cabinet

Area of the surface (A) was determined by using equation (5) as given by (Engineering Toolbox, 2003).

$$A = Length \times breadth \quad (5)$$

Given, length = 0.61m, breadth = 0.61m

A = 0.61 x 0.61

A = 0.3721m^2

From equation (4), recall $q = (K/S)AdT$

Given, A = 0.3721m^2 (from calculation), K = 0.17 (thermal conductivity of MDF),

S = 0.02m, t_1 = 160^{0}C, and t_2 = 29^{0}C (from measurement)

$$q = (0.17 \div 0.02) \times 0.3721 \times (160 - 29)$$
$$q = 8.5 \times 0.3721 \times 131$$
$$q = 414.3W$$

The heat flux is now known q = 414.3W

The heat rate is obtained by using equation (6) as given by (Engineering Toolbox, 2003).

$$Q = q \times A \quad (6)$$
$$Q = 414.3 \times 0.3721$$
$$Q = 154.16W$$

To know the thermal resistance of the insulator, the thermal resistance (R) can be obtained by using equation (7) as given by (Musa and Muktar, 2015).

$$R = X \div (KA) \quad (7)$$

Where,

R= Thermal Resistance

K= Thermal conductivity

A= Area

Recall, Area =0.3721m^2(calculated from equation 5)

Then, Thermal Resistance R is calculated to be

$$R = 0.02 \div (0.17 \times 0.3721)$$
$$R = 0.31617m^2K/W$$

3.3.3 Overall Heat Transfers Co-efficient

The overall heat transfer coefficient per unit area is obtained by using equation (8) as given by (Engineering Toolbox, 2003).

$$U = 1/(1/h_{ci} + S/K + 1/h_{c0}) \quad (8)$$

Recall, h_c = 2.044W/mK (from equation 2)

$$U = 1/(1/2.044 + 0.02/0.17 + 1/2.044)$$
$$U = 1/(0.4892 + 0.1176 + 0.4892)$$
$$U = 1/1.096$$
$$U = 0.91W$$

4.0 RESULT AND DISCUSSION

4.1 Testing of the Onion Preservative Machine

4.2 Performance Evaluation

Performance evaluation is the process of drying onions to maintain its nutrient and quality. The performance evaluation of the machine was carried out using 30 bulbs of 0 lost in weight of the onions. After running the machine for days, averages of data recorded are as follow for each

In the Morning **In the afternoon**

S/N	OFF (SECONDS)	ON (SECONDS)	S/N	OFF (SECONDS)	ON (SECONDS)
1.	15 for pick up	39	1	34 for pick up	12
2.	10	25	2	31	8
3.	8	22	3	32	7
4.	8	19	4	34	7
5.	8	17	5	34	7

In the Evening

S/N	OFF (SECONDS)	ON (SECONDS)
1	28 for pick up	9
2	25	9
3	24	9
4	26	9

5	26	9

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The onion preservative machine had been developed and the machine has been designed to make availability of onions higher all through the year. The performance evaluation had been carried out to maintain an effective and efficient circulation of conditioned air to the onions to aid and regulate preservation of onions. The method selected for preservation of onions in this machine was the best suitable for our environment (heat storage) because there are other method like "cold storage" but only suitable for a cold weather region.

5.2 RECOMMENDATION

From the performance of the machine and the problems faced using the machine, the following recommendations could be drawn out;

i. The numbers of trays in which the cabinet houses can easily be increase to accommodate more into the cabinet at a time but will require more outlet of the duct on top of each tray for effective circulation of conditioned air.

ii. Improvement can still be made on the machine by including humidistat on the machine control unit to be displaying the humidity level of the conditioned air in the cabinet.

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