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The Effects of Machine and Poultry Parameters on Feather Plucking

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ABSTRACT
A developed poultry feather plucking machine was evaluated using two breed (Isa Brown layer and Cockerel) at the machine speed of 225, 312, 369 and 426rpm, and scalding time of 30, 60 and 90 seconds. The left over feather on bird after machine operation were manually plucked and plucking efficiency calculated on mass basis. The results show that the machine performance on cockerel has highest plucking efficiency. The plucking efficiency decreased as the machine speed and scalding the increased. The overall mean performance was 67.65% (±16.45) and the maximum plucking efficiency of 99.43% was obtained on cockerel at 225rpm and 30 seconds scalding time. Analysis of variance shows no significant difference on breed but on machine speed and scalding time at 5% level. The machine is simple to operate and maintain, adopt and adoptable for the small and medium scale poultry farming.
Keywords: Poultry, Feather, Plucking, Efficiency.

I. INTRODUCTION

Poultry is a commonly practiced animal farming in West Africa. Chicken (fowl) being the commonest type of poultry are well adopted to the tropical environment and easily managed. Investment on chicken yield quick returns and products (meat and egg) are popular protein source and are of high domestic importance and provide raw materials for many industries. According to the National Bureau of Statistics of Nigeria (NBSN, 2011), poultry industry in Nigeria witnessed a great leap in the population of birds as well as the number of poultry establishments. This accounts to a great extent of the much needed protein to reduce the dependency on imported poultry products. Chicken production in Nigeria increased from 158,216,648 in 2006 to 192,313,325 in 2010.

The raising of animals is civilization itself. Animal domestication no doubt is a means of safeguarding the food supply for times when hunting was poor (Shoosmith, 1999).Most developing countries population growth is in geometric order while the total food production is in arithmetic order. This is true for livestock production particularly in poultry (Oniya et. al. 2011). The original habitat of the ancestor of modern breeds of chickens is south central of India; the Himalayan Tera; Ceylon and throughout all the countries to the southward and into Sumatra and Java with its string of lesser Islands to the eastward. The four known species of the wild fowl are the Red Jungle, Gray Jungle, Javan Jungle and the Ceylon Jungle.

Feather plucking is the most tedious processing stage in poultry production. This is the process of removing the feathers off the poultry. To obtain this, the poultry is scald in hot water 60-68^{0}C for 45-50 seconds; in case of geese for 1-3minutes and then introduce into plucking system. Mechanically, two basic types of plucking machine are employed. These are Table-top and tub-style plucking machines. Table-top consist of a rotating drum with plucking fingers. The operator holds to a bird close to the plucking fingers as the machine is working; while a scalded bird is dropped into the pluckier as in tub-style. It tumbles the bird around and the fingers flail all feathers off (David, 1999).

However, dry plucking achievable. Dry plucking machine usually consist of a shaft driving a plucking head by a belt, the plucking action is gentle; provide the skin is stretched tightly, no damage should occur, but it is important to work methodically and speedily (Buckland, 2005).

Therefore, the objective of this work is to study the effects of machine speed and scalding time on plucking efficiency of a developed three birds per batch capacity poultry feather plucking machine on Isa Brown Chickens.

II. MATERIALS AND METHODS

2.1 Description of the Feather Plucking Machine

An existing feather plucking machine (Plate 1) that was designed and fabricated at the engineering

department of Federal College of Agriculture, Ibadan was utilized for the study. The machine consists of three main units. These are the frame assembly, plucking and power transmission units. The frame is triangular in shape and bears the total weight of the machine. The plucking unit is made up of a drum designed to accommodate three birds per batch. The wall of the drum is stud with lots of rubber fingers and on the base a rotating plate housed by the drum also stud with fingers. A driving shaft connected to the base plate is powered by 2hp electric motor via pulley and belt arrangement.

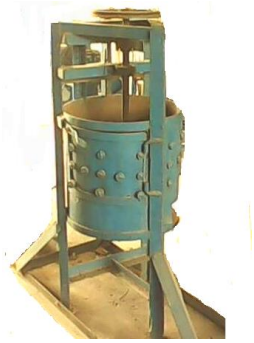

Plate 1: feather plucking machine

2.2 Experiment Procedure

Forty-five weeks Isa Brown Layers and twenty weeks Isa Brown Cockerels were obtained from a farm in Ogun State, Nigeria. The birds slaughtered by placing each one in a cone and the head cut off using a knife, and the blood drained for some minutes; then scalded in hot water of 70^0C for some seconds in a temperature control Bart. The bird was then introduced into the machine already switched on for about 10 seconds. The scalding time and plucking time were taken using a stop watch and spinning speed varied by means of a step turned pulley on the electric motor and machine speed confirmed using tachometer.

The machine was operated for 10 seconds and the bird discharged. The total machine plucked feathers was collected and the non-plucked feathers on the bird were plucked manually and were weighted using an electric weighting machine of 0.01g sensitivity.

A randomized complete block design (RCBD) of 4 x 3 x 2 (speed, scalding time and replicate) was used. The plucking efficiency was then calculated as:

$$\text{Plucking Efficiency } (\eta_{pt}) = \frac{W_{mp}}{W_{mp} + W_{np}} \times \frac{100}{1}\% \text{ --} \quad (1)$$

Where W_{mp} = weight of feather plucked by machine

W_{np} = weight of feather manually plucked

III. RESULTS AND DISCUSSION

The results of the machine performance are as presented in Table 1 with overall minimum and maximum plucking efficiency of 42.25% and 99.43% respectively; 44.47% and 99.43% for cockerel and 42.25% and 99.04% for layer. The analyzed Duncan and Analysis of various are presented in table 2 and 3, and the effect of speed and scalding time on plucking efficiency on Figure 1 and 2. From the evaluation (Table 1-3) and Fig. 1and 2, it shows that the layers had higher plucking efficiencies on machine and breed parameters but not significantly different at $P<0.5$ from cockerels. The overall plucking efficiency decreased from 80.81% to 53.63% as machine speed increased from 225rpm to 426rpm; while it decrease for 72.58% to 59.74% as scalding time increased from 30 seconds to 90 seconds. The relationships between the machine plucking efficiency (%) and the speed (N) and scalding time (T) are expressed as below:

Layer (η_{pt}) % = 0.149N + 0.221T
$R^2 = 0.84$

Cockerel (η_{pt}) % = 0.141N + 0.271T
$R^2 = 0.87$

The highest plucking efficiency of 99.43% was obtainable with breed cockerel, machine speed of 225rpm and scalding time of 30 seconds. The machine plucking efficiency decreased with increase in machine speed and scalding time. The breed (layer) feather bird ratio was found to be between 22.89 and 90.88 with overall mean of 46.25 $\pm$ 17.29 and carcass weighting 1.14 $\pm$ 0.33kg. Analysis of variance shows that the machine speed and scalding time and highly significant at $P \leq 0.1$; but the breed is not significant for plucking efficiency. The overall mean of the machine plucking efficiency is 67.65 $\pm$ 16.45%. The machine performance at higher temperature and less than scalding time (30secs.) is in agreement with David (1991), who recommended the temperature of 60 - 68^0C for 45 - 50 seconds scalding time. Therefore, scalding temperature of about 70^0 (hot water) which a commonly used temperature, the scalding time and machine speed should not be more than 30 seconds and 225rpm respectively. The slit better performance on layer than Cockerel might be due to age differences.

IV. CONCLUSION

The following conclusions can be drawn from study carried out.

- It was observed that Layer breed had higher plucking efficiencies on machine and breed parameters.
- The highest plucking efficiency was 99.43% and overall mean plucking efficiency was 67.65 $\pm$ 16.45%
- Plucking efficiency decreases with increase in machine speed and scalding time.

- For scalding tempering of about 70^0C (hot water), the scalding time and machine speed should not be more than 30 seconds and 225rpm respectively.
- The simplicity of the machine and maintenance without special training enhance its adoption for poultry processing in developing country like Nigeria.

V. Acknowledgement

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Table 1: Feather Plucking Machine Performance

S/N	Shaft speed (rpm)	Scalding time (sec)	Weight of machine plucked feather (WMF)g	Weight of hand plucked feather (WHF)g	Plucking efficiency %	Shaft speed (rpm)	Scalding time (sec)	Weight of machine plucked feather (WMF)g	Weight of hand plucked feather (WHF)g	Plucking efficiency $\frac{WMF}{WMF+WH} \times 100$ %	Weight of carcass (WC)kg	Ratio Feather/bird $\frac{WMF+}{WMF+WH} \times 100$ %	Overall Plucking Efficiency %
1	225	30	52.84	1.61	97.04	225	30	12.85	0.5	96.25	1.2	90.89	
2	225	30	77.27	0.44	99.43	225	30	45.25	0.44	99.04	1	22.89	
3	225	60	71.98	11.79	85.93	225	60	35.95	0.75	97.96	0.9	25.52	
4	225	60	93.34	28.45	76.64	225	60	22.34	6.45	77.6	1.05	37.47	
5	225	90	49.98	40.17	55.44	225	90	11.98	8.4	58.78	1.55	77.09	
6	225	90	49.15	24.4	66.83	225	90	17.15	7.4	58.78	1.55	77.09	
7	312	30	46.74	26.9	63.47	312	30	16.9	5.75	74.01	0.75	34.11	
8	312	30	90.01	8.78	91.11	312	30	36.04	2.78	92.84	1.55	40.93	
9	312	60	67.66	39.48	63.15	312	60	27.66	9.48	74.47	1	27.96	
10	312	60	47.15	22.2	67.99	312	60	25.15	10.2	71.15	1.15	33.53	
11	312	90	69.41	23.66	74.58	312	90	23.41	6.46	78.37	1.2	41.17	
12	312	90	61.85	31.86	66	312	90	22.91	10.86	67.84	1.1	33.57	
13	369	30	47.79	30.31	61.19	369	30	20.35	9.5	68.17	1.2	41.2	
14	369	30	50.66	30.55	62.3	369	30	13.15	7.15	64.78	0.8	40.41	
15	369	60	87.11	29.53	74.68	369	60	30.11	7.6	79.85	1.55	42.1	
16	369	60	66.27	27.45	70.71	369	60	10.34	4.55	69.4	1.1	74.88	
17	369	90	41.17	51.38	44.48	369	90	14.15	14.35	42.25	1.05	43.25	
18	369	90	36.63	45.41	44.65	369	90	10.5	14.35	42.25	0.05	43.25	
19	426	30	39.83	42.41	48.55	426	30	14	15.2	47.95	1.6	55.79	
20	426	30	39.55	42.54	48.18	426	30	13.65	15.45	46.91	1.3	45.67	
21	426	60	50.71	41.76	54.84	426	60	20.5	10	67.21	1.3	43.62	
22	426	60	50.97	42.55	54.5	426	60	11	14.1	43.82	1.15	46.82	
23	426	90	66	21.38	75.53	426	90	20.1	9.4	68.14	1.15	39.98	
24	426	90	59.76	26.3	69.4	426	90	8.55	11.56	42.52	1	50.73	

			5								
Mean		58.91	28.81	67.36			20.17	8.45	67.93	1.14	46.25	67.65
std. dev		16.32	13.46	15.35			9.44	4.53	17.81	0.33	17.29	16.45
Minimum		36.63	0.44	44.48			8.55	0.44	42.25	0.05	22.89	42.25
Maximum		93.34	51.38	99.43			45.25	15.45	99.04	1.6	90.89	99.43

Table 2: Effect of Machine Speed and Scalding Time on mean Feather Plucking Efficiency

		Layer	Cockerel	Plucking Efficiency %	Overall efficiency%
Speed	225rpm	81.40a	80.23a	80.81a	
	317rpm	76.45a	71.05b	73.75b	
	369rpm	61.12b	59.67c	60.39c	
	426rpm	52.76b	58.50	55.63c	
Scalding Time	30 secs	73.74a	71.41a	72.58a	
	60 secs	72.68a	68.56ab	70.62a	
	90 secs	57.37b	62.11b	59.74b	
Breed		67.93	67.76		
R^2	0.85		0.90		

Table 3: Analysis of Variance for Machine Speed, Scalding time and Breed on Plucking Efficiency

Source of variation	Df	Plucking efficiency % Mean square
Speed	3	1630.188***
Scalding time	2	765.196***
Breed	1	3.922N
Error	24	
Total Error	48	
Corrected total	47	

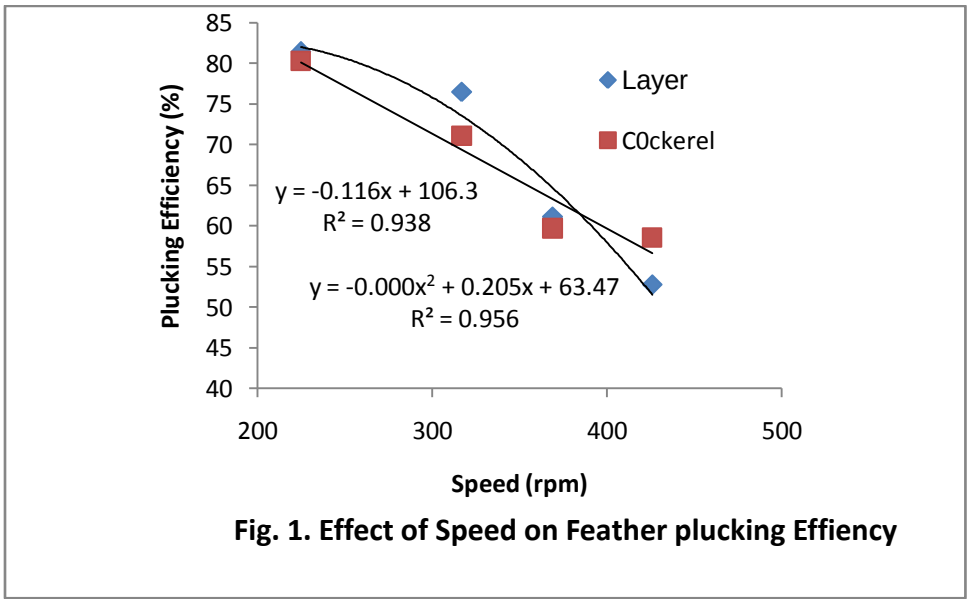

Fig. 1. Effect of Speed on Feather plucking Effiency

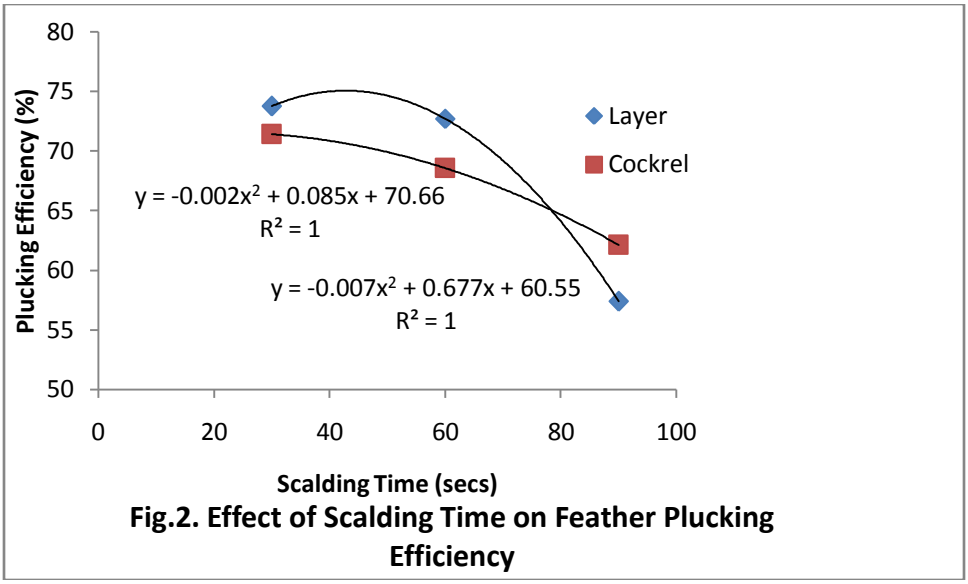

Fig.2. Effect of Scalding Time on Feather Plucking Efficiency