DEVELOPMENT AND EVALUATION OF PINEAPPLE (*Ananas comosus* [L.] Merr.) POMACE BASED EXTRUDER

BY

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CERTIFICATION

I certify that this research work was carried out by Mr. O. B. Oduntan in the Department of Agricultural and Environmental Engineering of University of Ibadan.

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ABSTRACT

In large scale juice processing, about 65% of the pineapple is extracted as juice, while the remaining 35% is the by-product called pineapple pomace. Pomace generated from juice processing constitutes a disposal problem and environmental pollution and there is no processing equipment designed in addressing this problem through the utilisation of this by-product. This study was designed to develop a mash extruder for pineapple pomace based flour.

Pineapple pomace was analysed for its proximate composition using standard methods. Pomace flour was produced by drying and grinding fresh pomace from a juice processing plant. The physical and mechanical properties of the pineapple pomace flour using cassava flour as the binder were carried out by standard methods. An experimental laboratory press was used to evaluate the extrusion point pressure at different pineapple pomace/cassava flour ratio mash (5:1, 6:1 and 7:1), the moisture content of the mash (50, 55 and 60%), die size (4, 6 and 8 mm) and temperatures (60, 80, 100 and 120^{o}C). Response Surface Method was employed to optimise the experimental data with extrusion point pressure as the response variable while temperature, moisture content, die size and pomace ratio were the independent variables. The results obtained were used to design and test a single screw pineapple pomace extruder. Operational power, compression ratio, throughput and efficiency of the extruder were determined using standard methods. Data were analysed using ANOVA.

Pineapple pomace contained 12.4% moisture content, 4.8% ash, 1.4% fat, 9.2% crude protein, 6.0% crude fibre and 66.2% carbohydrate. The static angle of repose and coefficient of friction at various combinations of pomace and cassava flours increased linearly for the entire surface with moisture content and varied with structural surface in the moisture range of 12.4 to 26.3% (d.b). The minimum value of coefficient of friction for stainless iron steel was 0.44 for pineapple pomace based flour. The extrusion point pressure was 7.51 ±

0.62MPa, temperature, die sizes and pomace ratio significantly ($p < 0.05$) influenced extrusion point pressure. Optimum conditions for the extrusion point pressure were 100°C; 4.0 mm die size, 55.0% moisture content and 6:1 pomace ratio at maximum desirability of 1:00. The power required to operate the extruder was 4.0 kW at a compression ratio of 3:1. Machine throughput was 26.1 kg/h with the extruding efficiency of 87.9%.

An efficient 4.0 kW pineapple pomace based extruder has been developed, which can be used to process and conserve pineapple pomace.

Keywords: Pineapple pomace-flour, Extruder-development, Point-pressure.

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To God who gives life, knowledge, understanding and wisdom, be all praise, honour and glory, Amen.

DEDICATION

To My God

Who Make My Way Prosperous, Wisely and Successful

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LIST OF ABBREVIATIONS

Symbol/ Abbreviation	Meaning	Unit
V_f	volume of flask containing the digest x 100	m^3
W_{sd}	weight of sample digested	mg
V_{ds}	vol. of digest for steam distillation	m^3
W_{as}	weight of ash	g
W_o	original weight of sample	g
MC_{db}	moisture content (dry basis)	%
MC_{wb}	moisture content (wet basis)	%
m_d	mass of dry matter	kg
m_w	mass of water to be added.	kg
ds	diameter of the screw shaft	mm
T	Torque transmitted by the shaft of extruder	Nm
δo	yield stress for mild steel.	Nmm^2
U_n	screw depth at the discharge end	mm
a	screw depth at the feed end	mm
n	number of screw turns	unit less
W_e	load that can be lifted by the screw	kN
T	Torque transmitted by the screw shaft	Nm
D_m	mean thread diameter	mm
μ	coefficient of friction	unit less
θ_n	thread (lift) angle	0^o
α	tapering angle	0^o

P_r	pressure developed by the screw threads	N/mm^2
A_p	pressing area	mm^2
h	screw depth at the maximum pressure	mm
P_b	pressure to be withstood by the barrel	N/mm^2
t	thickness of the barrel	mm
δ_a	allowable stress	N/mm^2
δ_o	yield stress of mild steel	N/mm^2
D_i	inside diameter of the barrel	mm
Q_t	theoretical volumetric capacity	$m^{3/}s$
D_{sf}	diameter of the screw flight	m
d_{ss}	base diameter of the screw shaft	m
P_s	screw pitch	m
N_s	rotational speed	rw/s
P_e	power required to drive the expeller	kW
Q_t	volumetric capacity of the worm shaft	$m^{3/}s$
l_s	length of screw shaft	mm
g	acceleration due to gravity	m/s^2
F	material factor	unit less