International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Portable Food Balls Extrusion Machine

Ana Maria A. Bonito

Abstract: ***This study developed a portable extrusion machine for food balls products. The study used the Research and Development (R&D) process for it involved the preparation and construction of a finished product that can be used in the field of education. The extrusion machine's cost efficiency was 10 times better than the manual method but twice lower compared to the commercial machine. There was significant variation in the weights of the food balls produced by the three methods, and the instructional and commercial value of the machine obtained an overall mean rating of 4.46 or very satisfactory. Thus, it is technically feasible to construct the portable extrusion machine in view of the expected functionality of the designed parts, the availability of supplies and materials and affordability of its cost. The construction of the machine requires procedure to follow for ease and accuracy. The portable extrusion machine is superior over the manual method but inferior to commercial units as to production ratio. Furthermore, it is more economically viable to use the portable extrusion machine for small-scale food balls production than the manual method. Potential for technology transfer/ generation and business incubation should be conducted before its release in the Philippine market***

Keywords: Food Science Technology, portable extrusion machine, research and development, Philippines.

I. INTRODUCTION

Fish balls meatballs, shrimp balls, squid balls, are among the popular food among Filipinos and are used in a wild array of dishes. Other than in the Philippines, food balls are also hugely known in Singapore, China, Malaysia, and Taiwan. In the US, they are available in most Asian groceries (Asian Journal on Science and Technology for Development (2001). These ball-shaped patties made of pulverized fish, ground meat of pork and poultry products are primarily white or yellow in color and measures about an inch or two in diameter. However, problems arise when the recipe is formulated like the preparation of the mixture which is time consuming. Moreover, food hygiene is compromised when the process is done manually. This problem is addressed by the proposed extrusion machine.

II. FRAMEWORK

The Encyclopedia of Food Science and Technology Volumes 2 and 4 (1990) clearly discusses food extrusion as a technology and its relation to food consumption matters.

Revised Manuscript Received on February 28, 2020.
***** Correspondence Author
Ana Maria A. Bonito*, Dean, College of Education Central Bicol State University of Agriculture Philippines.

It is a process that combines several unit operations including mixing, kneading, shearing, heating, cooling, shaping, and forming. It involves compressing a material to form a semi-solid mass under a variety of conditions and then forcing it to pass through an opening at a predetermined rate. This is one of the established technologies in food processing. According to Hagenimana (2006) extrusion applications are categorized as semi-finished products, which offer economic advantages over traditional processes like drum-drying in producing pre-gelatinized cereal flour, potato starch, and cereal starches; and as finished products, which have breakfast cereals, snacks food, and textured foods as the processed foods. Moreover, this covers as well other applications likes dry and soft moist pettings, croutons, full-fat soy flour, pre-cooked noodles, beverage bases, soup and gravy bases, and confections such as licorice, fruit gums and chocolate.

The commerciality of food production depends much on food technology and food selling. Thus, improvements and innovation need to be done for the development of new technologies and maintenance of old food processing equipment such as extrusion machine (DOST, 2000).

Food extrusion machines use single or twin screws to transport, mix, knead, shear, shape, and/or cook multiple ingredients into a uniform food product by forcing the ingredient mix through shaped dies to produce specific shapes and lengths.

Extrusion provides the foundation for continuous production. Food extruders are used to produce pasta and other cold formed products, cereals, snacks, pet food, feed, confectionery products including chewing gum, licorice, marshmallows, modified starches for soup, baby food, and instant foods, beverage bases, and texturized vegetable protein (Amestoso, 1999).

The advantage of extrusion is that it produces a more homogeneous and consistent cooking process, which leads to a final product of higher quality with minimum waste. Extrusion is a very efficient process, since all steps can be done in-line: mixing, cooking, forming, cooling, and cutting (Guy, 2001).

Extrusion is a highly valuable process because of its versatility to be used independently or in combination with other equipment and processes. In fact, when integrated with other processes like sheeting, depositing, filling, folding, crimping, cutting, and liquid or dry topping, the potential for creating innovative products is incredible (Frame, 1993).

Twin screw extrusion machine designed especially for foodstuffs produces breakfast cereals in number controlled shapes, sizes, colors and textures such as dried and toasted cereals,

processed extruded cereal beads for flaking and other shaped temperature sensitive or shear sensitive cereal products. The co-rotating twin screw extruders are engineered around the three separate assembles extruder barrel assembly, thrust bearing assembly, and drive assembly. It has an assurance of versatility, sanitation and maintenance convenience (Mollan, 2003).

The KP Foods "Savory Break" also known as Cadburry Criss Cross Industry, has the most sophisticated type of extrusion machine. This extrusion machine is designed for sweet snacks and biscuits production wherein the extruded tubes are cut to length with the cream injected into the individual pieces and into extruded woven outer part. This machine has shown its functionality and durability over the past years (Burtea, 2001).

The Robert Reiser and Company Incorporated has developed a series of unique co-extrusion system attached to the machine so as to produce a wide variety of food products including filled meatballs, croquettes, and other similar products. This X-200 Extrusion Cooker is a split/hinged barrel extruder with interchangeable extrusion components to give quick-change capability in processing meatballs and other food products (Fletcher et al., 1985).

An ocular inspection conducted by the researcher noted that the Camaligan Fish Processing Plant in Camarines Sur had an extrusion machine design for fish balls, squid balls, kikiam, and other similar food products. This machine can produce tons of fish balls and other food balls products per day which are being distributed in supermarkets throughout the country. According to the Plant Supervisor, this machine was imported from Japan and was manufactured by Komatsu Manufacturing. It has an optional automatic control, a time proven system, is simple, dependable and easily serviced. Optimum operating conditions are set and automatically maintained throughout the run duration, thus assuring product uniformity and quality control. A particular problem for this product was that no existing category existed for small scale production operation, and costumers did not know where to find them in the country.

III. OBJECTIVES

This study was conducted to develop and determine the comparative performance effectiveness of the portable food balls extrusion machine. Specifically, it aimed to:

1. Design and develop a portable food extrusion machine
2. Determine the comparative performance effectiveness of the machine as to: production rate; production cost; efficiency; and weight consistency of the food balls
3. Determine the perceived commercial and instructional value of the machine.

IV. METHODOLOGY

This study was guided by the Research and Development (R&D) process. The researcher followed these five (5) steps of the R&D process in the development of the portable food balls extrusion machine namely: planning, constructing the project, tryout and revisions and operational test final product revision.

The construction of the machine has five (5) major parts as shown in Figure 1 namely: stand assembly, extrusion assembly, guide plate and cutter assembly, motor assembly and funnel case assembly.

Fig. 1. Right photo shows the Funnel and Metal Case Assembly made of stainless steel. Left shows the mounting of the Motor & Extrusion Assembly.

The stand assembly is a flat bar box that holds the different major parts of the machine in order to function the different parts. The extrusion assembly is a stainless steel pipe that houses the spiral and shaft that process the materials in making food balls. The guide plate and cutter assembly are cold rolled steel which makes the food ball have the same size and shape and a stainless blade attached to the main shaft of the extrusion assembly. It ensures that the pieces of food balls will have the same size and shape. The motor assembly is equipped with one-half horse power motor that drives the extrusion assembly in processing the mixture for food balls. The funnel and metal case assembly are composed of the funnel made up of stainless steel which accepts the mixture that passes the extrusion assembly, the metal case which covers the various parts of the machine to make its appearance presentable and the slide holder which is the passage of the food balls from the machine to the container. Finally, in the operational test and final product revision, the machine was thoroughly tested based on predetermined criteria for quality assurance. Each part of the completed project plays a very important role in the effectiveness, efficiency and safe operation of the whole machine. Figure 2 shows the paradigm of the interrelationship of the parts.

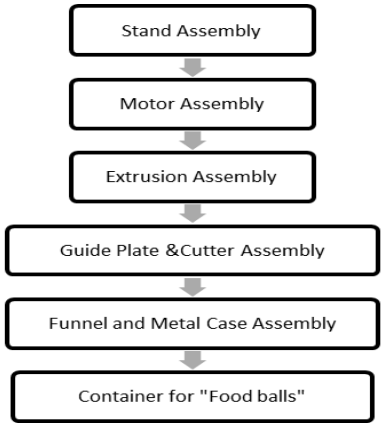

Fig. 2. Paradigm of Interrelationship of the Parts

In the stand/frame assembly, the base of the motor is mounted on and is connected to the extrusion assembly through a belt. It is reduced by the use of the two pulleys with a ratio of 2:1. The time the switch is turned-on; the machine runs and is ready to accept the material for food balls. This passes through a funnel, which is attached on top of the machines, going to the extrusion assembly. As the guide plate receives the material for the diameter of the food ball, the cutter rotates, shaping the material with uniform size. The cut food ball now goes to the slide holder/guide, and to the container. This is purposely placed on the funnel side of the machine, just below the slide older. Some parts of the machine are independent that failure could not relate to the breakdown of the whole unit.

Some parts, however, are interdependent with one another, so that the failure of one will be the failure of the whole unit.

The portable food balls machine was evaluated for its comparative performance effectiveness and for its commercial and instructional value as perceived by experts. A demonstration workshop was held to showcase the extrusion machine. Evaluator was composed of five experts. An evaluation sheet was used to determine the commercial and instructional value into thirteen indicators. The data gathered from the tryouts and evaluation sheet were tabulated. Weighted mean, Z-test and one-way anova was used to determine the effectiveness of the machine for food balls products.

V. RESULTS AND DISCUSSION

The design of the portable extrusion machine for food balls including parts, comparative performance effectiveness evaluation, commercial and instructional value.

Table- I: Design Parts of the Portable Extrusion Machine

General Description	Portable Extrusion Machine for Food Balls
Parts	1. Stand Assembly
	2. Extrusion Assembly
	3. Guide Plate Assembly
	4. Motor Assembly
	5. Funnel Case Assembly
Applications	Extrude two sizes of food balls 16mm and 20mm diameter

A. Comparative Performance Effectiveness Evaluation of the Machine

A demonstration was held to showcase the extrusion machine. The three Food Technology instructor experts manually formed balls of one recipe for meatballs, fish balls and rice-balls. The working time, weight and shape were accordingly measured or noted.

Table- II: Comparative Production Rate

Method	Production Pieces	Time (Hour)	Production Rate
Manual	99	2	50/Hour
Proto-Type	100	0.17	588/Hour
Commercial	100	0.004	25,000/Hour

***use 50 grams sample or 1 recipe food ball mixture**

B. Production Cost Efficiency

This is the cost incurred for labor and power relative to the quantity of worth of the food balls produced using 1 recipe sample. Table 2 shows the method, production rate, labor rate, power cost and labor cost to arrive at the production cost. On the other hand, using similar sample in mass of food balls mixtures a commercial machine also has the capacity to manufacture 100 pieces in 0.004 hours.

Table- III: Comparative Cost Efficiency of the Portable Extrusion Machine

Method	Production Rate	Power Cost	Labor Cost	Production Cost
Manual	50 pcs/hour		20,000/hour	0.40 Php/pc
Extrusion Machine	588 pcs/hour	6.00/hour		0.04 Php/pc
Commercial Machine	25,000 pcs/hour	524.25/hour		0.02 Php/pc

From the above mentioned data, findings revealed that the lowest production cost was noted in the commercial extrusion machine while the higher production cost was detected in using the manual method.

Furthermore, findings deduced that the production cost efficiency of the portable extrusion machine was 100% with respect to manual method and 50% with respect to commercial machine.

C. Weight Consistency

The physical characteristics of the food balls as to weight consistency were monitored.

Table- IV: Comparative Weight Consistency of the Produced Food Balls

Method	Mean Weights
Manual	6.06
Extrusion Machine	5.502
Commercial Machine	5.0

Summary of mean weights of food balls products produced out of three (3) methods namely: proto-type extrusion machine, commercial machine and manual operation were compared.

Data showed that the mean weight of food balls products produced by portable extrusion machine was 5.502 grams; commercial machine 5.0 grams and manual operation was 6.06 grams. To determine the significant difference among the three methods of production in terms of weight consistency, an analysis of variance was used using 5% level of significance.

From these data, there was a significant variation on weights of food balls products produced using the three methods. Findings also showed that portable extrusion machine exhibited more or less the average weight of manual and commercial machines. It can be used by small scale entrepreneurs in their small-scale business for mass production of food balls.

D. Commercial and Instructional Value of the Machine

The instructional and commercial value of the machine obtained an over-all mean rating of 4.46 which is very satisfactory.

"Designed to achieve its purpose", "A time saving device",

"Safe and economical in operation", and "Facilitate the teaching learning process" categories were all rated excellent. The category "roundness of balls better than the manually produced" followed by quality of "bola-bola" was rated 3.8 and easy to clean with a 4.0 mean rating.

VI. CONCLUSIONS

1. It is technically feasible to construct the Portable Extrusion Machine in view of the expected functionality of the designed parts, the availability of supplies and materials and affordability of its costs.
2. The construction of the machine requires procedures to follow for ease accuracy.
3. The portable extrusion is superior over the manual method but inferior to commercial units as to production ratio.
4. It is more economically viable to use the portable extrusion machine for small-scale food ball production than the manual method.
5. The food balls produced by the Portable Extrusion Machine were less consistent in weight than the food balls produced by the commercial machine.

VII. RECOMMENDATIONS

1. To ensure its functionality, the machine should be constructed according to its specification.
2. The specification of the major parts and the construction procedure is accordingly observed to ensure construction accuracy and functionality of the machine.
3. The portable extrusion machine is recommended for use in small scale, food balls production in view of its cost efficiency and for increased profit.
4. For bigger volume of food balls output, the portable extrusion machine is recommended for use in small scale food ball production.
5. Further study to improve the weight consistency of the food balls produced should be made on the machine design

REFERENCES

1. F. J. Amestoso, "Single screw extrusion processing of pasta from sweet potato" (Ipomoea batatas L.) flour, 1999
2. Encyclopedia of Food Science and Technology, 1990, Volume 2, pp. 1134-1143
3. Encyclopedia of Food Science and Technology, 1990, Volume 4 page 1147
4. Equipment News, Asia Pacific Food Industry, August, 1990, pp. 8, 86-95. September 2(9) 87-95
5. Food Processing Industry, Quality Improvement, Asian Journal on Science and Technology for Development, 2001
6. Fisheries Administrative Order, No. 211 s.2001, 2001
7. S. I. Fletcher, P. Richmond, & A. C. Smith, An experimental study of twin-screw extrusion –cooking of maize grits. Journal of Food Engineering, 4(4), 291-312, 1985.
8. A. Hagenimana, X. Ding, & T. Fang, Evaluation of rice flour modified by extrusion cooking. Journal of Cereal Science, 43(1), 38-46, 2006.
9. O. Burtea, Snacks foods from formers and high-shear extruders. Snacks Foods Processing, EW Lusas and LW Rooney (eds.) Technomic Publishing Co. Inc., Lancaster, PA, 281-314, 2001.
10. R. Guy (Ed.), Extrusion cooking: technologies and applications. Woodhead publishing.
11. N. Frame (Ed.), Technology of Extrusion Cooking. Springer, 1993.
12. M. Mollan, Historical overview. DRUGS AND THE PHARMACEUTICAL SCIENCES, 133, 1-18, 2003.

AUTHORS PROFILE

Ana Maria A. Bonito, PhD**,** is currently the Dean, College of Education Central Bicol State University of Agriculture Philippines. She is an accreditor of the Accrediting Agency of Chartered Colleges and Universities in the Philippines, Incorporated. and an Associate Member of the National Research Council of the Philippines.

She graduated with the degree of Bachelor of Secondary Education Major in Technology and Livelihood Education from Bicol College of Arts and Trades, Naga City Philippines. She earned her Master of Arts in Teaching Technology Education at the Camarines Sur Polytechnic Colleges, Naga City and Doctor of Philosophy in Development Education from Central Bicol State University of Agriculture Philippines.

She had attended various National and International Workshop in Research. She has done researches in Social Sciences and Food Product Development which were presented in local and international fora. She is also a Consultant of King Thomas Learning Academy, Sipocot Camarines Sur Philippines.