International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 11 | Nov 2025 www.irjet.net p-ISSN: 2395-0072

Automatic Dough Extruder and Fryer

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Abstract - *The Automatic Dough Extruder and Fryer is a novel equipment that uses a fully integrated 3D extrusion and air-frying technology to automate the shaping and frying of classic Indian snacks like chakli (murukku). Traditional chakli manufacture requires manual shaping and deep frying, which leads to uneven product quality, high labor demand, and wasteful oil consumption. The machine's components include a dough hopper, screw extruder, rotary cutter, air-frying chamber, and a programmable control system based on PLC and HMI. A conveyor-based transfer system synchronizes the extrusion and air-frying processes, ensuring precise shape and uniform oil-free cooking. The technology decreases human intervention, lowers oil usage by up to 90%, and improves production uniformity. With its compact, modular design, the machine is suitable for domestic, small-scale, and commercial snack manufacturing. The developed prototype demonstrates a significant improvement in uniformity, hygiene, and process efficiency compared to traditional methods.*

Key Words: Food automation,, 3D extrusion, Air fryer, PLC control, Snack processing, Mechatronics, Sustainable food manufacturing

1. INTRODUCTION

Preparing traditional Indian delicacies like chakli or murukku can be time-consuming and unreliable. Manual shaping, cutting, and deep-frying need competent operators, but they also result in uneven cooking and extra oil absorption, increasing health concerns. To overcome these challenges, automation in food preparation has become increasingly popular. With advancements in electromechanical systems and programmable controllers, it is now possible to construct small, automated, and health-conscious food preparation equipment.

The Automatic Dough Extruder and Fryer combines extrusion and air-frying technologies in a single device. Unlike typical chakli-making machines, which solely handle extrusion, this design incorporates a synchronized process that combines shape and frying into a single automated cycle. This development contributes to the "Make in India" movement by facilitating efficient, small-scale, and sanitary snack production.

2. METHODOLOGY

2.1 System Overview

The invention comprises two major modules:

1. **Dough Extrusion Unit:** Includes hopper, screw extruder, nozzle, rotary cutter, and drive motor.
2. **Air-Frying Unit:** Consists of heating coils, fan, air ducts, and conveyor mechanism. These units are integrated on a steel frame for compactness and stability, ensuring coordinated operation.

2.2 Control System Design

The process is controlled using a Programmable Logic Controller (PLC) and Human Machine Interface (HMI). The PLC regulates extrusion speed, nozzle motion, temperature, and frying duration. Feedback sensors such as temperature, proximity, and pressure sensors ensure accurate process control and safety.

2.3 Operation Process

- **Step 1:** The user fills the hopper with chakli dough.
- **Step 2:** The extruder forms the chakli shape using a nozzle guided by PLC commands.
- **Step 3:** The formed chaklis are automatically transferred to the air-frying chamber.
- **Step 4:** Hot air circulates uniformly within the chamber, ensuring oil-free, even frying.
- **Step 5:** After frying, the chaklis are discharged automatically onto a cooling tray.

This continuous cycle results in uniform product quality and reduced manual intervention.

2.4 System Overview

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3. STRUCTURE

The automated dough extruder and fryer comprise two main modules: (1) Dough Extrusion Unit and (2) Air Frying Unit. These units are mounted on a metal frame (steel or aluminum) that ensures stability and mobility. Non-structural elements are fabricated from plastic or wood for aesthetic design and insulation.

3.1 Dough Extrusion Unit: This section includes a dough hopper, screw extruder, rotary cutter, nozzle block, extrusion motor, gearbox, pressure sensors, and product conveyor. These components work together to extrude chakli shapes with precision and consistency.

3.2 Air Frying Unit: This section includes the heating system, electric heater, frying conveyor, temperature sensors, oil tank (optional), and cooling conveyor (optional). Hot air is circulated uniformly using fans and ducts, ensuring even cooking and crisp texture with minimal oil.

3.3 Control and Electrical System: The system is governed by a PLC (Programmable Logic Controller) and an HMI (Human Machine Interface) for user control. Additional components include variable frequency drives, limit switches, proximity sensors, overload relays, emergency stop, and alarm indicators. Through the control panel, the user can set parameters such as shape, extrusion speed, temperature, and cooking time.

3.4 Operation: The hopper is filled with dough manually. The operator enters desired parameters via the control interface. The PLC activates motors to extrude dough into chakli shapes. Shaped chaklis are automatically transferred to the air fryer. The air fryer activates, circulating hot air for even, oil-free frying. Cooked chaklis are discharged via a side door using a conveyor belt.

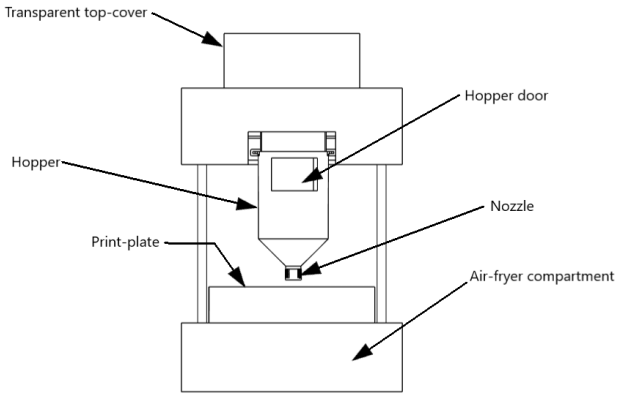

Fig. 1: Labeled front-view of the machine

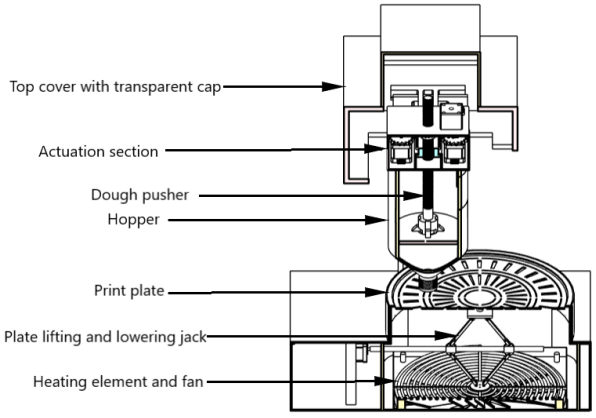

Fig. 2: Sectional side-view of the machine

4. CONCLUSIONS

The Automatic Dough Extruder and Fryer automates chakli production by integrating extrusion and air-frying within a single programmable unit. The system ensures uniform shape, consistent frying, and up to 90% reduction in oil consumption compared to manual methods. Its compact and hygienic design improves productivity and

ease of operation, making it suitable for small-scale and domestic use.

The invention's novelty lies in combining a programmable 3D-style dough deposition mechanism with an air-frying system in one compact apparatus. This integration enables complete automation from dough feeding to finished product, maintaining shape precision and promoting healthy, oil-free cooking.

Owing to its efficiency and versatility, the system is ideal for small-scale food industries, cloud kitchens, bakeries, and home kitchens seeking standardized, healthy snack production. Overall, the invention represents a practical, sustainable advancement in food automation aligned with modern manufacturing and health standards.

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