NVEO
Natural Volatiles &
Essential Oils

Prolong Freshness of Foods By Maintaining Vacuum Pressure

Maheswaran S[1], Sathesh S[2], Vivek B[3], Deepika M[4], Divya Dharshni M[5], Boopesh Raja K J[6], Mohan Raj[7]

[1]*Associate Professor, Department of Electronics and Communication Engineering, Kongu Engineering College, Erode-638060, India.*

Email: mmaheswaraneie@gmail.com

[2,3]*Assistant Professor, Department of Electronics and Communication Engineering, Kongu Engineering College, Erode-638060, India.*

Email: sathesh808@gmail.com , vivekerode2005@gmail.com

[4,5,6,7]*Scholor, Department of Electronics and Communication Engineering, Kongu Engineering College, Erode-638060, India.*

Email: deepikamoh2001@gmail.com, divyadharshnibe@gmail.com, kjboopesh@gmail.com, mohanraja20002@gmail.com

ABSTRACT

Most of the grocery shops and cottage food production use the manual way of weighing and packing by using candles and sealing machines. It consumes much time and also labour work. Vacuum packing is a formation of altered atmosphere packing found throughout the world. Vacuum packing eliminates O2 from the packaged products which are put in. Oxygen is the fundamental cause for product decay. Bacteria associated with the O2 in air causes decay of food. Air contains 21% of oxygen in which the bacteria grows. While reducing the O2 level in packing, there is less chance for the survival of bacteria. Also, when the food reacts with the oxygen it causes the change in colour, odour and flavour. The elimination of oxygen can often help increase shelf life of a product. The fundamental form of vacuum packing eliminates O2 from the bag and seals when vacuum packing is finished. Vacuum packing method can also be used in the packing of meat and fish products which increases the shelf life. In this project we are mainly focused on fruit and vegetable vacuum packing. The traditional method of freezing seafood products can be complemented. The large-scale industries that use the automatic packing and vacuum sealing machine are high in cost and consumes a large area. The purpose of the machine is to extend the shelf life, reduce cost and pay workers in small and medium scale industries. The prolonged freshness of food by packing can be done by creating a vacuum using a vacuum motor, product is filled in the packet and place in a load cell in which the weight of the product can be measured and the output is given to the ATMEGA328P, which display the weight of the product. After a vacuum is created, pressure is sensed and sealed. The cover is controlled by using stepper motors, it gives stable speed control though it has changing load and provides continuous torque over an extended speed. The fruits were preserved (at room and refrigerated temperature), evaluated from chemical reaction. The lifespan of the fruits was expanded under the condition of vacuum packing (with room and refrigeration temperature) from first to fourth weeks respectively as shown in the result.

INTRODUCTION:

At present, the consumer demand increases, the demand in food also increases. The food is important for life. If the wastage of food is decreases the food demand can also be decreased. In food processing packing and sealing plays a vital role in preservation of products, safe handling and delivery of fresh agricultural products [4-6]. The vacuum packing removes the air and keeps complete and airtight. The most important reason for creating vacuum in packing is to remove the oxygen from around the product that we are going to store so that the bacteria can't grow in the oxygen.

O2 is the highly reactive element and most of the organic components in food materials act with oxygen and that effect in change of odour and flavour. If in the absence of oxygen, the product retains its natural quality. Oxidizing enzymes catalyse chemical reactions between O2 and food materials, and that effect in spoilage of food. Oxidizing enzymes that cause darkening in vegetables after cutting are catalase and peroxidase [7-9]. For example, apples show signs of oxidation by browning. This method of packing eliminates contact with the air and thus prevents oxidation. Rancidification is the process of causing a substance to become rancid, unpleasant odor and taste [10]. This is the reason for autoxidation of fat using oxygen.

Vacuum packaging prevents oxidation and preserves fine oil [1]. We pack or wrap food to keep it from hardening on exposure to air; air causes moisture to vaporise. By removing the air, packing the food's natural wetness is retained along with all its flavour and texture [10-12]. Desiccated foods, unless they are kept in an airtight box, quickly damage as wetness in the air softens them. By vacuum packing of food materials we can maintain the natural flavour of the product and can extend shelf life [13-17]. This equipment can be used in packing continuously in grocery shops, supermarkets, ration shops etc., it is also an advantage for customers as it has an easy way of billing

The processes of the machine are as follows:
    I. Automation of machine using arduino
    II. Fill the product in cover
    III. Vacuum creation and packing
    IV. Sealing

Objective:
    The main intention of the product is to lower the time consumption for sealing and packing and also to shrink the manpower and also to extend the life of the product in small scale and medium scale industries. The large scale industries uses the automatic packing and vacuum sealing machine are high in cost and consumes large area. By creating a vacuum we can avoid the spoilage of food change in colour, freshness, odour and rancidification, freezer burn. Preventions of some processes such as oxidation of lipids, dehydration, fading and protection of nutrients such as vitamins.
The major objectives G2are:
    I. The intention of the machine to extend the life of the product
    II. To design a flexible packing machine.
    III. The intention is to create a machine with easy handling and runs simply
    IV. To create a machine which is space consuming.
    V. The intention of the machine to provide clean bag filling
    VI. The objective of the machine is provide accuracy and time consumption
    VII. Provide higher quality of product.

SCOPE:
    This product has many application in ration shops, groceries, departmental stores etc,
Some of the applications are listed below:
- Packing in small scale food industries
- Automatic weighing and billing in departmental shops
- In packing of meat and seafood items
- Packing of fruits and vegetables in shops
- Packing of cereals and dry fruits.

- Packing of cheese
- Packing of homemade sweets like candy and chocolates

LITERATURE REVIEW:

In [1], In this paper, the design is for packing small scale cereal with the capacity of packing 1 kg per minute. The significance of automatic weighing, packing and sealing is the low-priced and more operative probability of food packing machines. For this innovation, the intention was to plan a machine which will be easy to operate and maintain. It costed up to USD 300. (appx). For designing a machine of substantial quality by using correct materials which can endure for five years.

The conception has a hopper from where the cereals to be chockfull are plummeted inside. The product quantity of the film is runned by a rotating weight meter which is at the bottom of the hopper. The weight the quantity of the product is weighed using the weight meter and at the same time its rotation from this product passes into the plastic film. Below the weight meter rollers present which are sealed between two meshes by the thermoplastic films. Other rollers divide the product and cut the pack from the meshes. The packages falls out. The seal thickness is determined by the roller. The study of the intent operates with the power-driven principles. The fee is reasonable as portrayed by the bill measures. The maximum volume of filling one packet in a period of 1 minute which can weigh up to 1 kilogram in this machine. We would suggest for the machine improvement that the range of weights can be packed and from the spring plastic holder the plastic should move automatically.

In [2], this paper incepts mechanical, hydraulic, pneumatic and electric devices into machinery to improve their productivity. The working of invention is, the conveyor is used to pass the products, sense using proximity sensor and set the counter to 1 by using microcontroller. After passing the sensor, sensor 1 will switch off. Timer starts which is previously set in delay. After that, the cylinder extends and the film is sealed. Sensor 2 detect the extended cylinder and set the counter as 0. This procedure is repeat for certain time.

Sensors are:

 I. Inductive sensors:

It is used to detect the metal object for which it uses current which is induced by magnetic fields.

The change in inductance of the coil is the net effect. It identifies the metal object by measuring the inductance

of the metal object. It can detect any type of metals.

II. Capacitive Sensor:

It senses a variety of things like electric field, motion and variables indirectly that are changed to relative permittivity of acceleration, pressure composition.

Built with dielectric electrodes with 5 volts of excitation voltages.

III. Photoelectric Sensors:

It is other type of position sensing sensor. It is similar to that light either broken or reflected by goal. The controller has an emitter, receiver to find the emitted light and amplify detected signal. From this we get the point that the automation in the packing of product with different size based on PLC. Photoelectric sensors detect the fault ending of lagging and leading of invention based on the programming cunning and the different sized product packing takes place.

In [3], In this paper, they designed a weight monitoring system is added separately. The load cell provides the correct measure of the product to be packed in the container. When the container is packed by an explicit quantity of product, it alternates then the product fall into the form tube. The vessel is rotated by an arrangement of disk and air cylinder. The form collar's designed structure is unique from that the film plastic is converted to round film of vertical. For the bottom and top seals of the packet we have to place two horizontal sealers. It is actuated by pneumatic cylinders. Draw rollers pulls the formed plastic downwards and are placed vertically on the forming tube. By using the motors, the rollers are rotated. Cutter is fixed in the middle of the horizontal seal to separate bags. The automation of the machine is elaborated by using information and the same on mechatronics systems and bendable computerisation procedures. Because of the simple designs and habit of components having minimum cost consistent for the project, the proposed apparatus at a low cost as compare to conventional machines discussed above. So, the automation of low cost Machine is a triumph, developed that is useful for small scale Industries and enterprises. The machine requires very less human involvement so that workers safety is achieved.

In [4], In this paper, fresh and processed meat industry find new solution in packing of the products due to increase in demand. This industry mainly focuses on increase of meat expiry, its appearance and effective cost. Biodegradable films using biopolymer, green packing and packing using nanocomposite are used to solve problems in packing. It is based on packing using material of vapor barrier after alteration in gas environment. Which change in packing environment and product. Gas contains oxygen, carbon dioxide and N2. Mixture of gases containing oxygen, nitrogen, carbon dioxide. The fresh meat contains up to eighty percentage of oxygen with thirty percentage of carbon dioxide which is the reason for bright red color. The color changes to dark red, brown or green is the reason for the increased period owing to the fact of myoglobin oxidation.US has approved for transporting the fresh meat along with CO (0.4%). When CO binds with meat packing myoglobin results stable colour. The use is restricted as limited all over the world.

 Methodology:

I. To Make blueprint of the model
II. 3D Model
III. Collection of required hardware components
IV. Programming in the Arduino UNO
V.   Fill the product manually in cover.
VI. A load cell to weigh the product. And display in LCD display.
VII. Microcontroller triggers the motor by the driver to hold the pack.
VIII.A small tube is inserted in between to extract the air by vacuum motor.
IX. Pressure sensor is used to check if air is present in the pack after vacuum.

X. After removal of air, the packet gets sealed using a heating strip.

PROPOSED METHOD:

In the existing method the machine is large and designed for a particular product, in our project we design a machine which will be suitable for different products and time for vacuum creation is less. In this the product is manually put into the cover either zip log or normal cover and placed over the load cell for weighing, the weight is displayed in the LCD display. Load cells can weigh up to 5 kg. Then the Arduino gives a trigger to the gear motor drive to hold the cover by strip. Between that tube is placed and the vacuum motor will create a vacuum inside the cover, a pressure sensor is used to check the vacuum and give feedback to the Arduino. Arduino gives a trigger to the gear motor drive to seal the pack by heating the element and the product is vacuum packed [18].

Figure 1- 3D model of a Machine

Components used in automatic weighing and packaging machine:

Load cell sensor:

It converts measured weight into an electric signal it is can be changed to voltage, current and frequency, based on circuit and load cell type. Load sensors are under the principle of piezo-resistivity. The resistance is changed, by the time of providing any load or force to the sensor. When an input voltage is applied, there will be a change in resistance which causes changes in output. In practical application, these are particularly unbending, have responsive echo values, and life span is longer. It works on the principle" The strain gauge bends just at the moment the material load cells distort". Electrical resistance of the strain gauge changes when deformation occurs, by the amount that is proportional to strain. Calibration process is conducted at a regular increase, starting working in ascending order or descending order.

Figure 2 - Load cell

Arduino Uno (Microcontroller):

It is a microcontroller unit which is mounted on a circuit board which has processor, memory, and I/O pins. It is an ATmega328 microcontroller board. It contains 14 I/O digital pins among that 6 as PWM output pins, 6 pins for analog inputs, crystal oscillator of 16MHz, a universal serial bus connector, and also electric switch. Arduino UNO has its own Integrated Development Environment.

Figure 3 - **Arduino Uno**   **Figure 4** - **Stepper Motor**

Stepper Motor:

It's a brushless DC motor which splits one full revolving into an equal number of steps. Motor position is instructed to change and without position sensor feedback it holds in one step. With regards to torque and speed motor is sized to application. It is a DC motor which moves as discrete steps. Group of multiple coils is called "phases" We can achieve an accurate position or speed by computer control stepping. For precision motion control applications, a stepper motor is chosen.

Stepper Motor Driver:

Used to drive the stepper motor. It requires voltage or current that is not produced by the controller. For that we need a driver. It converts our gesture commands from a controller into a series, which provides enough power into it, where the winding of copper wire in the motor will turn on or off.
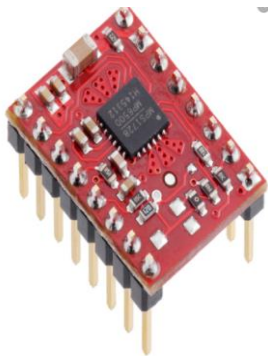

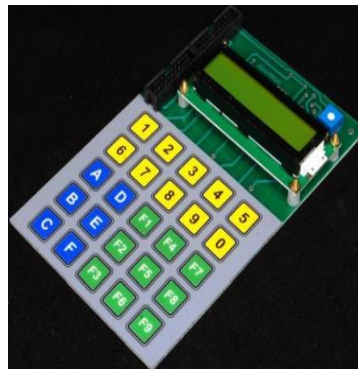**Figure 5** - **Stepper Motor driver**   **Figure 6** - Keypad

Kit for Keypad and LCD:

Keypad given feed in value of the appropriate product number. Values are displayed in the LCD. This used because of,

- Multi-tap access to all alphabets A-D, numbers and symbols.
- To adjust settings in the menu escape key is used.

RESULT AND DISCUSSION:

The prolonged freshness of foods by packing machine is used to increase the mean life of foods especially fruits, cereals and vegetables. But few of the fruits and vegetables are not capable of vacuum packing. They need air for respiration. If it is vacuum packed it produces its own toxic gas without air and which is harmful to human health also. Mostly the fruits which ripen after snatch from the tree are not suitable for vacuum packing. Vacuum packing of corn gives a better result in extending the shelf life.
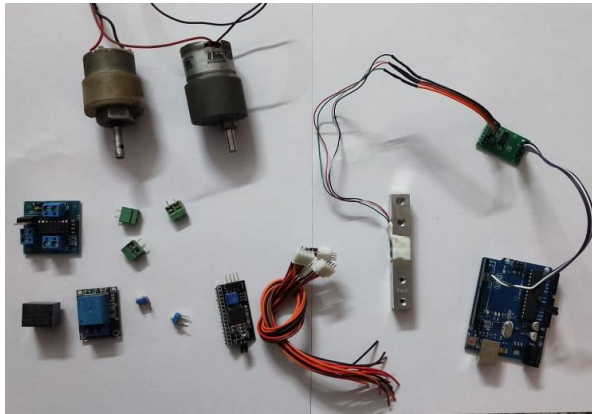
Figure 7 - Components

The most important reason for creating vacuum in packing is to remove the oxygen from around the product that we are going to store so that the bacteria can't grow in the oxygen. Oxidizing enzymes in food react with oxygen and cause bad taste, colour and spoil the food. By extending the shelf life we can keep some products for a long time and use them. Figure 6 represents the components used in our project. Figure 7 represents the welding work done for the frame.
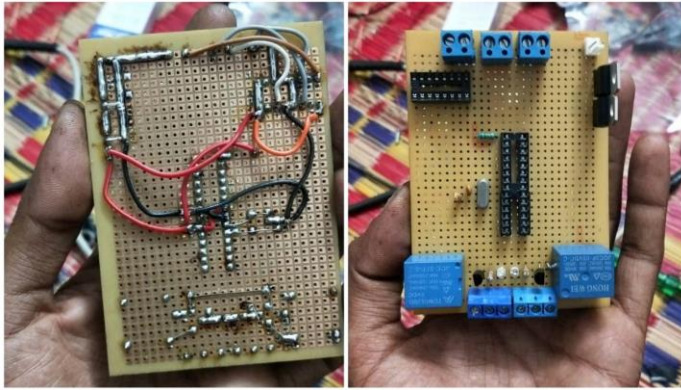

Figure 8 - Welding work

Figure 9 - Soldering work

Soldering work and PCB work are shown in figure 10. The machine consists of a motor drive connected to the two-gear motor, load cell, HX7111 ADC, pressure sensor, vacuum motor, heating strip are connected to AT mega 328p. Power supply is provided to the module. When the product is put into the cover manually and placed over the load cell which is at the bottom of the machine. Then the weight is displayed in the LCD display, then a motor attached to the strip folds the cover by motor drive. Figure 9 represents the software output obtained using the Arduino platform.
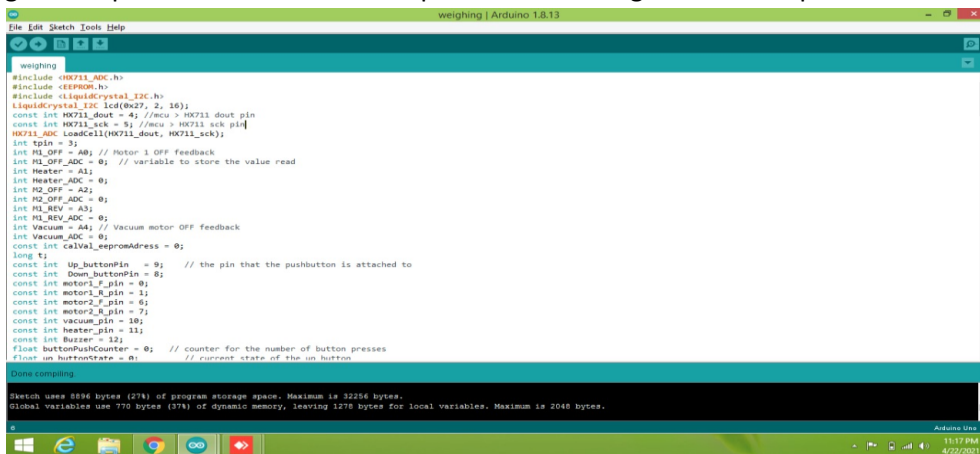

Figure 10 - Programming output

Vacuum is created using a vacuum motor through a tube from top between the strip and checks the pressure by a pressure sensor, which gives input to the controller and it checks the pressure. Further there is air inside, again giving a trigger to the vacuum motor to create vacuum. Then the motor along with the heating strip fold the cover and seal the pack, then the strip is going to its original position. Now the vacuum sealed pack is prepared. Figure 10 represents output obtained during the packaging.
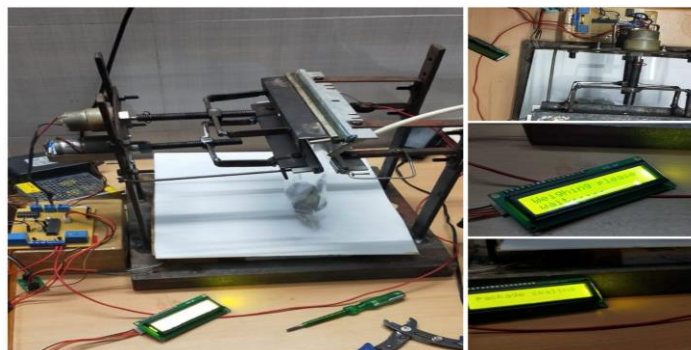

Figure 11 - Output obtained during packaging

After vacuum packing the apple, it is kept for experiment and the collected dates of moisture content of apple at temperature of 30 ,40 and 50 degrees Celsius is shown in figure 12. And moisture content of vacuum-packed apple at 10, 25 and 50 KPa is shown in figure 12.
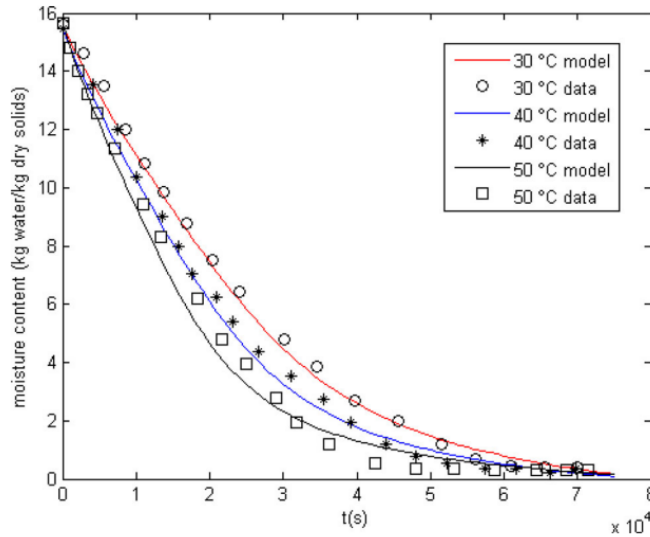

Figure 12 - moisture content of vacuum-packed apple at temperature of 30, 40, and 50 C.
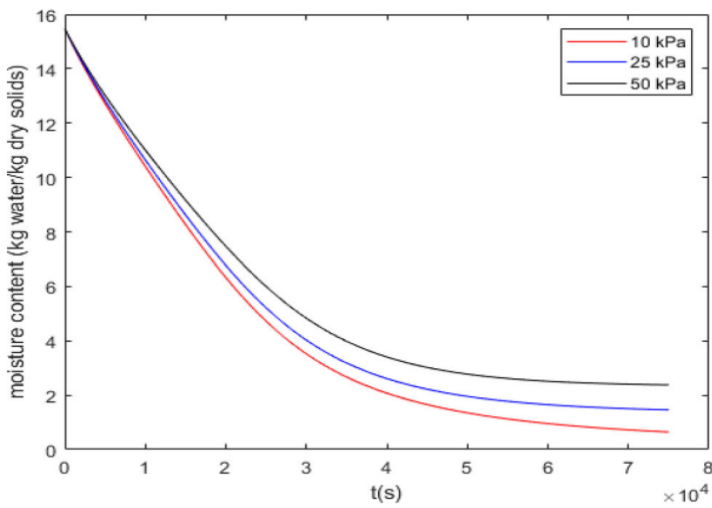

Figure 13 - moisture content at the time of vacuum of the apple at 10, 25, and 50 kPa.

Conclusion:

Prolonging the freshness of food by packing machine can do automatic weighing, create vacuum inside the pack and seal, and return the bag with highest efficiency of manufacturing. Working in a simple method also has less chances of weight calculation error being almost negligible. It reduces the time consumption, paid workers, manual weighing and packaging are minimized. Material is manually filled; LCD displays the measured weight. Load cell gives value to the Arduino which the motor drives to move the strip for holding the cover. The vacuum is created inside the package. Vacuum level is checked by the vacuum pressure sensor, if there is air inside the package then it will create vacuum

again else the package is sealed using the heating strip. Vacuum packing of corn gives good results in extension of shelf life. It keeps the fruits and vegetables fresh for a long time. Because Air contains 21% of oxygen in which the bacteria grow. While reducing the O2 level in packing, there is less chance for the survival of bacteria

[5-18]

REFERENCE:

[1]   Mushiri, T. and Mbohwa, C. (2015) 'Design of a small scale cereal packaging machine suitable for developing countries'.

[2]   Shashank Lingappa, M. and Bongale, V. ('Sreerajendra,"PLC Controlled Low Cost Automatic Packing Machine"', *International Journal of Advanced Mechanical Engineering, ISSN,* pp. 2250-3234.

[3]   Saraf, M., Ruiwale, V., Kulkarni, V., and Kulkarni, S. (2016) 'Design and Development of Cost Effective Automatic Machine for Powder Packaging'.

[4]   Maheswarappa, N. B., Mohan, K., and Jagadeesh, D. S. (2016) 'Meat Products Packaging'.

[5]   Xu, L. (1998) 'The principles and design of packaging mechanics', *Shanghai Science and Technology Press, Shanghai*.

[6]   Aquino, R. S. A., Cabalinan, M. E., Cruz, J. R. B., Lao, F. S., and Baldovino, R. G., "An Automated Vacuum Packaging and Sealing Machine for Coconut Sugar Production," in *2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)*, 2019: IEEE, pp. 1-4.

[7]   Davis, S., King, M., Casson, J. W., Gray, J. O., and Caldwell, D. G., "Automated handling, assembly and packaging of highly variable compliant food products-making a sandwich," in *Proceedings 2007 IEEE International Conference on Robotics and Automation*, 2007: IEEE, pp. 1213-1218.

[8]   Santana, Á. L. and Meireles, M. A. A. (2014) 'New starches are the trend for industry applications: a review', *Food and public health,* Vol. 4, No. 5, pp. 229-241.

[9]   Chemists, A. o. O. A. and Horwitz, W., *Official methods of analysis*. Association of Official Analytical Chemists Washington, DC, 1975.

[10]   Falade, K. O. and Okafor, C. A. (2013) 'Physicochemical properties of five cocoyam (Colocasia esculenta and Xanthosoma sagittifolium) starches', *Food Hydrocolloids,* Vol. 30, No. 1, pp. 173-181.

[11]   Kader, A. A., Zagory, D., Kerbel, E. L., and Wang, C. Y. (1989) 'Modified atmosphere packaging of fruits and vegetables', *Critical Reviews in Food Science & Nutrition,* Vol. 28, No. 1, pp. 1-30.

[12]   Li, M. *et al.* (2011) 'Extrusion processing and characterization of edible starch films with different amylose contents', *Journal of Food Engineering,* Vol. 106, No. 1, pp. 95-101.

[13]   Panghal, A., Khatkar, B., and Singh, U. (2006) 'Cereal proteins and their role in food industry', *Indian food industry,* Vol. 25, No. 5, p. 58.

[14]   Pantastico, E. B. (1975) 'Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables'.

[15]   Pascoal, A. M., Di-Medeiros, M. C. B., Batista, K. A., Leles, M. I. G., Lião, L. M., and Fernandes, K. F. (2013) 'Extraction and chemical characterization of starch from S. lycocarpum fruits', *Carbohydrate polymers,* Vol. 98, No. 2, pp. 1304-1310.

[16]   Pérez-Pacheco, E. *et al.* (2014) 'Isolation and characterization of starch obtained from Brosimum alicastrum Swarts Seeds', *Carbohydrate polymers,* Vol. 101, pp. 920-927.

[17]   Ryall, A. L. and Pentzer, W. T., *Handling, transportation and storage of fruits and vegetables. Volume 2. Fruits and tree nuts*. AVI Publishing Co., Inc., 1982.

[18]   Zhu, F. and Wang, Y.-J. (2013) 'Characterization of modified high-amylose maize starch-α-naphthol complexes and their influence on rheological properties of wheat starch', *Food chemistry,* Vol. 138, No. 1, pp. 256-262.