International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

EFFECT OF TEMPERATURE, PRESSURE AND FRYING TIME IN VACUUM FRYING: A REVIEW

Akshay Shah [1] Dhruv Patel [2] Jesal Rathod [3] Ramtirth Joshi [4] Bhargav Ramani [5]

Assistant Professor [1] UG (B.Tech) Student [2,3,4 5]

[1,2,3,4,5] Department of Mechanical Engineering

[1,2,3,4,5] Indus Institute of Technology and Engineering, Ahmedabad, Gujarat, India

---

Abstract: *Vacuum frying is new technology which uses lower pressure and temperature compared to normal atmospheric deep frying. Vacuum frying has many advantages over normal frying such as less oil uptake, less frying time, less shrinkage, can preserve natural color and flavor, and has less adverse effects on oil quality. Vacuum fried products consist of fruits, vegetables, fish and wheat based snacks. The vacuum frying process involves low temperature so that the attributes of the fried foods are improved. Different foods require different frying time and temperature depending upon the thickness. The paper reviews food processing technology vacuum frying systems and discusses the equipment design, parameters of the system, processes optimization. The system needs specialized equipment for the frying process and design is quite sophisticated and easy.*

Keywords: Vacuum frying, vacuum fried products, vacuum technology, food processing equipment, vacuum fryer.

Introduction:

Vacuum frying is a special and a unique way of food processing, as it has many advantages over the normal atmospheric frying. Vacuum frying poses some advantages that include: (1) can reduce oil content in the fried product, (2) can preserve natural color and flavors of the product due to the low temperature, (3) has less adverse effects on oil quality. Even though frying is an old process of manufacturing a food product, most of the research found in the literature is related to atmospheric frying. The color was significantly affected by the oil temperature and vacuum pressure. This technique of vacuum frying produces chips that have physical, physicochemical, chemical, and sensorial properties generally better than chips produced by normal deep-fat frying methods.

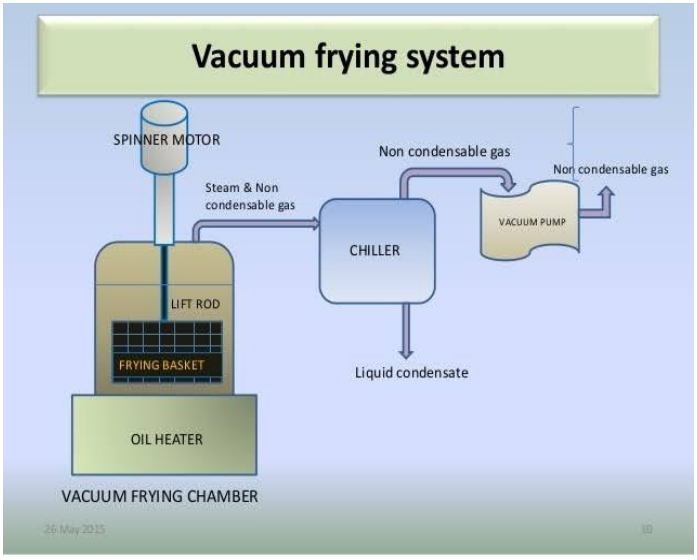

Figure 1, *a sample vacuum frying system.*

PROBLEM OF ATMOSPHERIC FRYING:

- 33%-44% of oil content can be reduced by using a vacuum frying system.
- High oil temperature is required compared to vacuum frying.
- Frying oil needs to be changed frequently in atmospheric frying.
- More frying time required than vacuum frying.

- Natural color and flavor are not preserved in atmospheric frying.

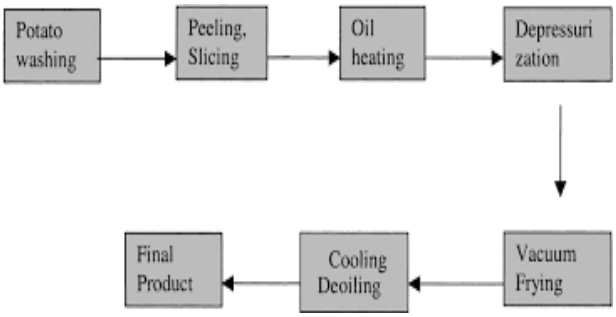

Figure 2, Flow diagram of the vacuum frying process

LITERATURE REVIEW:

Jagoba Garayo and Rosana Moreira had done research on Vacuum Frying of potato chips. It was used as an alternative technique which could reduce the oil content in potato chips. By the effect of oil temperature and vacuum pressure quality of chips was tested such as color, shrinkage and texture. Thereafter the characteristics were compared to potato chips fried at atmospheric conditions. It was observed that low vacuum pressure and high temperature reduces oil content and the hardness of the chips increased and color had no difference as compared to atmospheric frying. The main purpose of using this type of frying was to evaluate the feasible method for production of low content potato chips. The rate of oil absorption was directly affected by the moisture loss. The maximum loss or the highest oil absorption rate was obtained at T=144 degree Celsius and lowest vacuum pressure P= 3.115 kPa .In this research, the conditions tested did not affect the color or the texture at the end of frying. The shrinkage of the chips decreased when the temperature of oil increased and vacuum pressure decreased .Also the drying rate of both the methods were the same and the quality of chips were softer than chips fried under atmospheric condition.

C.Granda, R.G.Moreira and S.E.Tichy were researching the reduction of Acrylamide formation in potato chips by using vacuum frying. There were two main objectives behind this research study. To analyses the level of acrylamide formed during deep-fat frying of chips and to evaluate the means of reducing acrylamide in chips by using different cultivars and vacuum frying. Cultivars such as Innovator, Shepody, Atlantic were used. The frying operations were conducted at three temperatures 118, 125, 140 degree Celsius and vacuum pressure of 10 Torr. By this, the formation of acrylamide reduced to 94%. Also it was observed that cultivars and modified frying systems played an important role in reducing acrylamide formation. The effect of formation of acrylamide was more in traditional frying.

Fitriyono Ayustaningwarno and Kristina Ananingsih Indonesia based had researched on the vacuum frying of fresh fruits that have high moisture content and can further produce crispy products with the help of frying method. The research done in Indonesia have high taste and different types of fruits which can be turned into value added product with help of vacuum frying. The Advantages of using vacuum frying include oil reduction in the fried product, can preserve natural color, flavors and texture of the product because of low temperature and has less effect on quality of oil.

Amany, M.M.Basuny, Shaker, M.Arafat, Azza, A.A.Ahmed were finding an alternative method to obtain high quality potato chips and fried oil. The reason behind it was to study the effect of different frying processes on properties of potato chips and to get better quality of the oil. Sunflower oil was tested with both the process atmospheric and vacuum frying for 20 mins each hour in a 4 hour gap. The study revealed that the test of vacuum frying was better as the chips obtained from it were of acceptable quality and also improved the quality of the frying oil. There were significant differences observed between vacuum frying and atmospheric frying as the vacuum fried chips gave the lowest moisture content and the moisture content in atmospheric frying was slightly higher. By using this method, observations such as oil content was less, sensory evaluation had higher value, acid value increased slightly rather than increasing strongly as atmospheric frying, peroxide value same as the acid value increased slightly, better oil quality can be maintained because of polar content, oxidized fatty acids content was low in vacuum frying as the content of this acids were high in atmospheric frying. From the results of this research study, it was observed that desirable quality of potato chips were obtained which were more quality product than atmospheric frying.

Fitriyono Ayustaningwarno , Vicenzo Fogliano, Ruud Verkerk has done research on vacuum frying effect on fruits to improve color, retention, nutrients, to reduce oil content and the factor effect on vacuum fried fruits are quality is equipment, osmotic drying, blanching, freezing, impregnation. They have mainly consider quality attributes, matrix of different fruits, phytochemicals, and equipment used. It says that during the reaping process fruit matrix and chemical composition will change which gives effect on quality of fried fruit and it describe special case of tropical fruits it have different ripening properties firmness, texture and porosity.

N.Ranasalva and K.P.Sudheer have studied the effect of vacuum frying of banana chips to improve the quality of it to reduce oil content. They have done pretreatments freezing, blanching cum drying and gum coating. And at determine pressure(20kpa) and temperature(100* C) blanching cum shows significant oil reduction but not customer satisfactory freezing shows high acceptance with high oil content 38.2% and the gum coating treatment was on par with untreated vacuum fried chips. And untreated vacuum fried chips with centrifugation at 1000rpm for 5min gives the best result with 13.4% oil content and wide acceptance.

Soumitra Banerjee and Chandan Kumar Sahu have done an overview of vacuum frying and their benefits. It states that vacuum frying is healthier than normal frying it reduces health problems and has lower oil content and tests better, natural color. Vacuum frying is done at lower temperature and pressure, it gives satisfactory results in quality attributes and reduces health problems than conventional frying and it reduces lipid content of the final product, higher rate of moisture evaporation is another advantage.

Masoud Hasemi Shahraki has done research on vacuum frying is effect on veggies fruits and other, during the process physical chemical and sensory characteristics of food are modified. atmospheric deep fat frying occurs at high temperature and atmospheric pressure while vacuum frying can be done in low temperature and low pressure absence of air during frying may inhibit oxidation reaction, including lipid oxidation, enzymatic browning. It is an efficient method to reduce acrylamide content of products. It gives significant effect on color also and pressurization period also has an important role in oil absorption.

Ahmad Dwi Setyawan , Sugiyarto , Solichatun , Ari Susilowati has done research on physical, physical chemistries, chemical and sensorial characteristics of the several fruits and vegetables chips produced by low temperature of vacuum frying machines . Frying process is one of the oldest and widely practiced cooking methods in the world. Food frying can extend the shelf life of fruits and vegetables and frying oil is used to enhance the flavors but improper frying oil can have harmful effects on human health. Vacuum frying is a promising technology and has become an option for production of fruits and vegetable chips that present the desired quality and respond to the new health trends. They reviewed some of the conventional frying techniques used in food preservation and focused on recent advances for food production and characteristics of some chips of fruits and vegetables processed by low temperature vacuum frying machines. The study found out that vacuum frying techniques are potential to increase the added value of chips, both nutritionally and economically. Fruit and vegetables are processed with vacuum frying, have better nutritional value, texture, color, and other sensory characteristics than traditional deep fat frying and also reduce the formation of harmful substances such as acrylamide and excessive saturated oil, thus meeting the demands of modern public health.

Tanushree maity, A. S. bawa and P. S. Raju has done Research on Effect of Vacuum Frying on Changes in Quality Attributes of Jackfruit bulb slices. The effect of frying temperatures and durations on the quality of vacuum fried chips were evaluated. The frying time for jack fruit chips was 30, 25, and 20 minutes at 80, 90, and 100^0C, respectively. This study showed that the quality characteristics of fried jack fruit chips such as color and texture increased after frying but up to a critical time temperature. Lower frying temperature retains maximum bioactive components of the jack fruit such as total phenolic, flavonoids and carotenoids and optimum quality of jack fruit chips can be obtained if the material is fried under vacuum at 90^0C.

Jamaluddin, Budi Rahardjo, Pudji Hastuti, Rochmadi and Gufran D. Dirawan has done the research on The Evaporation of water and oil absorption during the vacuum frying of fruit chips. This research develops a

mathematical model of heat and mass transfer when frying fruit pieces in a vacuum. The sample jackfruit is fried at a temperature of 70- 100^{0}C, in an old frying pan for 15-60 minutes with a vacuum pressure of 80-90 kPa. This model is based on the concept of lump capacitance. The ordinary differential equations that are solved with the aid of the Runge-Kutta numerical method. The result of this study is that the vacuum pressure and temperature affect the rate of temperature change, evaporation of water and oil absorption during frying of jackfruit solids. According to the water content in solids the rate of evaporation of the water affects heat transfer rate and the rate of oil absorption. When water content in solids is steel above 50%, then the solids temperature is constant at 60 to 80^{0}c , at which water boils in vacuum with a pressure of 80 to 90 kpa . When the water content in solids is under 50 % than the oil absorption rate increases when the rate of evaporation decreases. By using changes in physical properties during frying the mathematical model of heat and mass transfer development can be applied to estimate the temperature rise, decline in water contain and oil absorption.

Lemuel M. Diamante, Geoffrey P.Savage, Leo Vanhanen and Reiner Ihns had researched study on vacuum frying of apricot slices in which the main observations were effects of frying temperature, time and levels of moisture, color and texture properties. Response surface methodology was used to investigate the effects of all the observations on vacuum fried apricot slices. The moisture content and color change of these slices decrease with increase in frying temperature and time. The maltodextrin did not affect the moisture content, browning index and pressure of penetration. When the product was vacuum fried at 100c and frying time of 65 mins and the level of maltodextrin kept at 70 percent, the product was observed to be of acceptable moisture, color and texture properties.

Conclusion:

The main reason of using vacuum frying was to evaluate its feasibility for production of natural color and low oil content potato chips. From the literature review it is clear that vacuum frying system promises to produce high quality fried food products. But there is a need to work on the small scale vacuum frying and make it economical. Vacuum fried products no doubt are less oily, natural color and flavor after frying compared to the fried products from atmospheric frying.

Acknowledgment:

Foremost, I would like to express my sincere gratitude to my guide Prof.Akshay Shah for the continuous support of my project study and research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research. I could not have imagined having a better advisor and mentor of my project study. I offer my special gratitude to all the faculty members, mechanical engineering department, Indus University for their help and support. I would like to express endless gratitude to “MY PARENTS” who gave me everything they could to enable me to reach the highest possible education level. I only hope that they know how their love, support and patience encouraged me to fulfil their dream.

References:

1. Jagoba Garayo and Rosana Moreira “Vacuum frying of potato chips” Journal of Food engineering 55 (2002) 181-191.Department of Biological and agricultural engineering, Texas A&M University, College station, TX 77843-2117, USA

2. C. Granda, R.G.Moreira and S. E.Tichy “Reduction of Acrylamide formation in potato chips by Low-temperature Vacuum frying” Vol. 69, Nr. 8,2004-JOURNAL OF FOOD SCIENCE E405 published on Web 10/7/2004

3. Fitriyono Ayustaningwarno and Kristina Ananingsih “Vacuum frying Usage on Increasing Food Diversity” Student of food science postgraduate program at IPB Bogor Indonesia and Lecturer of Faculty of agriculture techonology, Soegijapranata Catholic university, Indonesia

4. Amany, M.M.Basuny, Shaker, M.Arafat, Azza, A. A. Ahmed “Vacuum frying: An Alternative to obtain high quality potato chips and fried oil” Global Advanced Research Journal of Microbiology Vol. 1(2) pp.019—026, March, 2012

5. Effect of vacuum frying on Quality attributes of fruit: By Fitriyono Ayustangwarno, Vicenzo Fogliano, Ruud Verkerk, Matthijs Dekker,25 April 2018.

6. Effect of pretreatments on quality parameters of vacuum fried riped banana chips: By N.Ranasalva and K.P.Sudheer,18 December 2017.

7. Review on vacuum frying promising technology for healthier and better fried foods: By Soumitra Banerjee and Chandan Kumar Sahu, issue 2 June 2017**.**

8. Vacuum frying: By Masoud Hasemi Shahraki, February 19 2020.

9. Ahmad Dwi Setyawan, Sugiyarto, Solichatun, Ari Susilowati "Physical, physical chemistries, chemical and sensorial characteristics of the several fruits and vegetables chips produced by low temperature of vacuum frying machines" Nusantara bioscience, Vol. 5, 2, pp.86-103 November 2013

10. Tanushree maity, A. S. Bawa and P. S. Raju "Effect of Vacuum Frying on Changes in Quality Attributes of Jackfruit bulb slices", Hindawi Publication Corporation, international journal of food science vol. 2014

11. Jamaluddin, Budi Rahardjo, Pudji Hastuti, Rochmadi and Gufran D. Dirawan "The Evaporation of water and oil absorption during the vacuum frying of fruit chips" global journal of engineering education, vol. 18, no. 2, 2016

12. Lemuel M. Diamante, Geoffrey P. Savage, Leo Vanhanen and Reiner Ihns "vacuum frying of apricot slices" journal of food processing and prevention, ISSN 1745-4549.