Bulletin of Culinary Art and Hospitality

Volume 2 | Issue 2 Article 5

12-30-2022

Design of Vacuum Packaging Tools to Increase the Resistance of Processed Cook Fish Products

Brilliant Mahardika
Faculty of Engineering, Mechanical Engineering Study Program, Universitas Singaperbangsa Karawang, H S. Ronggowaluyo Street Telukjambe Karawang, 41361, Indonesia, brilliant.mahardika12@gmail.com

Eka Andriani
Faculty of Engineering, Mechanical Engineering Study Program, Universitas Singaperbangsa Karawang, H S. Ronggowaluyo Street Telukjambe Karawang, 41361, Indonesia, brilliant.mahardika12@gmail.com

Recommended Citation
Mahardika, Brilliant and Andriani, Eka (2022) "Design of Vacuum Packaging Tools to Increase the Resistance of Processed Cook Fish Products," *Bulletin of Culinary Art and Hospitality*: Vol. 2: Iss. 2, Article 5.
DOI: https://doi.org/10.17977/um069v2i22022p61-69
Available at: https://citeus.um.ac.id/bocah/vol2/iss2/5

Bulletin of Culinary Art and Hospitality
Vol 2, No 2, December 2022, pp. 61-69
ISSN 2797-8249

Design of Vacuum Packaging Tools to Increase the Resistance of Processed Cook Fish Products

Brilliant Mahardika*, Eka Andriani

Faculty of Engineering, Mechanical Engineering Study Program, Universitas Singaperbangsa Karawang, H S. Ronggowaluyo Street Telukjambe Karawang, 41361, Indonesia
** corresponding author, email: brilliant.mahardika12@gmail.com*

ARTICLE INFO

Article history:
Received: 20-05-2022
Revised: 16-06-2022
Accepted: 10-10-2022

Keywords:
Fish cork
Vacuum machine
Product

ABSTRACT

Processed snakehead fish product is a fishery product that is prone to decay during storage for a certain time. One of the efforts to inhibit the rotting of processed snakehead fish products in the form of nuggets is by packaging using a vacuum machine. Therefore, in this study will carry out the design of a vacuum machine. The design of this vacuum and packaging machine is carried out for the purpose of extending its service life and increasing the selling value of processed snakehead fish nugget products. The machine to be designed is expected to be capable of packaging in a short time and at an affordable price. This machine has several parts, for example, vacuum motor, vacuum clamp, body frame, and impulse sealer. The machine to be made has dimensions of 700mm (height) × 700mm (length) × 500mm (width) using an Arashi Ais type impulse sealer with a size of 40cm and the vacuum motor used is the V115N 2 CFM type. This vacuum machine is equipped with an on/off switch in the vacuum clamp section whose main function is to connect and break the electric current that enters the vacuum motor so that the vacuum motor will immediately start and stop. How to operate this vacuum machine is very easy, as easy as inserting a plastic package containing snakehead fish products into the sealer and clamping the vacuum clamp at the end of the package. This vacuum machine is equipped with an on/off switch in the vacuum clamp section whose main function is to connect and break the electric current that enters the vacuum motor so that the vacuum motor will immediately start and stop. How to operate this vacuum machine is very easy, as easy as inserting a plastic package containing snakehead fish products into the sealer and clamping the vacuum clamp at the end of the package. This vacuum machine is equipped with an on/off switch in the vacuum clamp section whose main function is to connect and break the electric current that enters the vacuum motor so that the vacuum motor will immediately start and stop. How to operate this vacuum machine is very easy, as easy as inserting a plastic package containing snakehead fish products into the sealer and clamping the vacuum clamp at the end of the package.

I. Introduction

Generally, Indonesia is a country with a dense population, which is a very potential market for producers in the fishing industry (Listyanto & Andriyanto, 2009). At the end of 2011, the national fishery income reached 12.39 million tons (capturing 5.41 million tons and yields from the cultivation of 6.98 million tons). The amount of cultivation from freshwater fish was 1.1 million tons, and the rest was from pond water cultivation and the sea fish. Among freshwater commodities with high economic value, the snakehead fish is a native fish from Kalimantan and Sumatra provinces (Kusmini et al., 2018).

Business competition in the industrial world is getting tighter in food products, goods, and services. Consequently, many large and home industries require innovations and new progress (Afrinda & Myori, 2020). Processed snakehead fish products are one of the developing food industry businesses. Therefore, many producers cultivate snakehead fish because of its convenience cultivating, relatively stable selling prices, high demand, and very high nutritional value. Those factors influenced many snakeheads fish cultivation (Anderson et al., 2021).

Nowadays, processed snakehead fish is increasingly varied, the most common currently encountered by consumers is snakehead fish, such as fried or made into soup, now there are also many people who sell and process snakehead fish into crackers. Processing results from snakehead fish cultivation can also be used as the main ingredient for making nugget or frozen food (Pariyanto et al., 2021). The shape of nugget is common with the nugget that consumers usually encounter such as fish nugget, chicken nugget, and beef nugget. Even the taste is not much different from nugget in general

For marketing and selling the results of processing snakehead fish, home industry players are still in the form of kilo nugget using plastic and sacks (Deepa et al., 2013). This results in durability, hygiene levels, and a selling price that is not comparable and cheap (Nurilmala et al., 2021). One of the ways and efforts to solve this problem is by using a packaging device called a vacuum. By packaging the product using a vacuum it is hoped that it can increase the usage period of about 1 month and the selling value of processed snakehead fish products in the form of nuggets (Iftadi et al., 2013).

The data above implies that the need for packaging in the food industry will also continue to show positive growth. Most food products on the market have been packaged in such a way as to make it easier for consumers to recognize and transport them. Indonesia's consumption of plastic products per capita is still around 10 kg/capita/year, relatively low compared to other ASEAN countries such as Singapore, Malaysia, and Thailand which have reached figures above 40 kg/capita/year (Yohana et al., 2014). The potential for increasing plastic demand in Indonesia is still quite large.

The need for national plastic products is around 4.6 million tons per year with an average growth of 5% per year in which the largest portion (40%) is for plastic packaging. Demand for plastic packaging was mainly driven by growth in the food and beverage industry (60%) and other fast moving consumer goods (FMCG). Industries using plastic that are also quite large are component industries (automotive and electrical/electronic), construction (building profiles, pipes, cables), and household appliances. The turnover of the national packaging industry in 2011 reached IDR 40 trillion, of which 51% of the turnover came from plastic packaging. The turnover of the packaging industry in 2012 is estimated to grow 10%. Consumption of plastic packaging in Indonesia in 2011 was around 1.8 million tons. Meanwhile, from the supply side, the utilization of plastic packaging production in Indonesia has been relatively stagnant at the level of 70% (Wibisono & Hasibuan, 2022). In 2020, the estimated volume of annual beverage plastic packaging consumption in Indonesia amounted to 971 thousand metric tons. Plastic packaging is among the most collected plastic waste in Indonesia in 2018 (Statista Research Department, 2021).

Generally, the current packaging for snakehead fish nuggets is only put in ordinary plastic wrap and then closed using a strapless and then packaged and sold directly to consumers. With this conventional packaging method, the risk of spoilage in the product is very high and also makes the expiration date very short. Therefore, in this case, better packaging using a vacuum machine is needed to support the marketing of processed snakehead fish products. By being packaged using a vacuum device, this vacuum device will inhibit the absorption of free oxygen in the form of water into the packaged product packaging. There are 2 types of vacuum packaging machines that are common in the market, namely using conventional machines and non-conventional machines. Furthermore, after the vacuum process on the food packaging is complete, it will proceed to the next process, namely the closing process at the end of the product package or commonly known as sealing (Listyanto & Andriyanto, 2009). Based on the problems that have been explained, it is necessary to design a vacuum and packaging machine that can vacuum and seal in a short time, make a vacuum machine with a size that is not too large, easy to operate and at a low cost to minimize risks that can result in losses. for small industry players because the products produced are far from hygienic and do not have a high selling value (Afrinda & Myori, 2020).

II. Method

A. Tool Design Flow Chart

The flow chart system shows the vacuum machine's creation process, symbolized by forms with agreed meanings and functions. The flow chart of this vacuum is depicted in Figure 1.

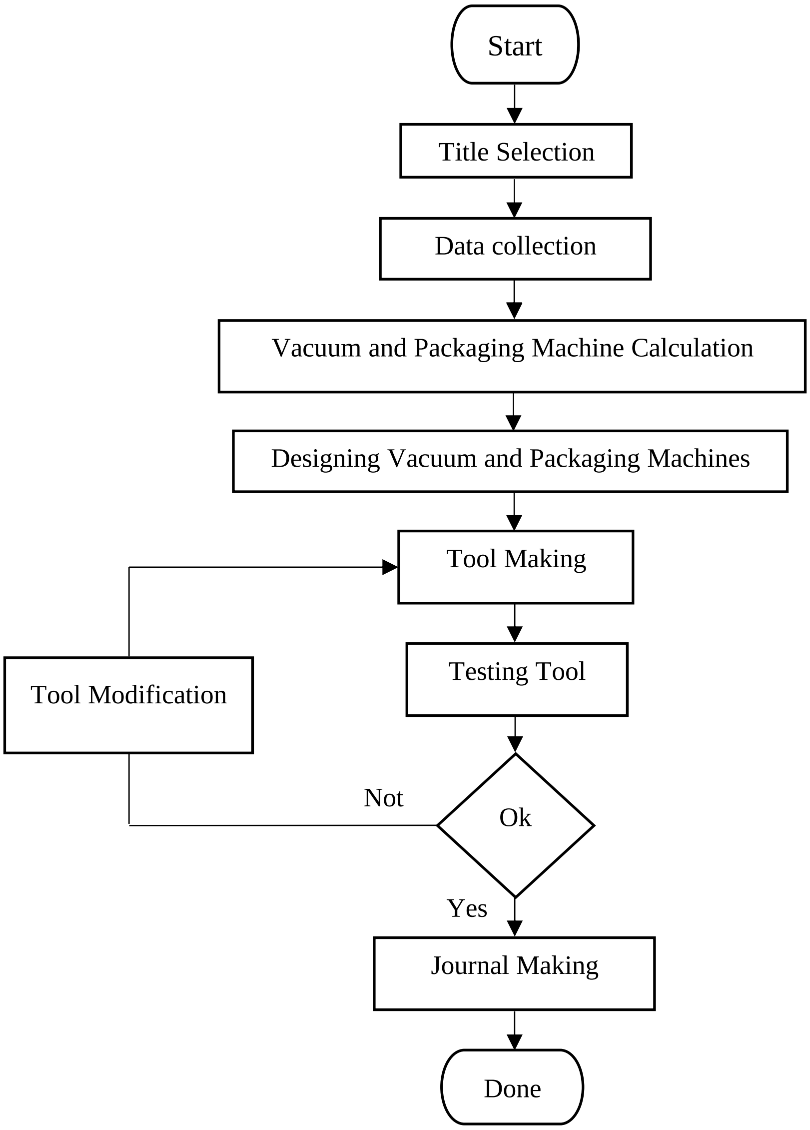

Fig. 1. Tool Making Flowchart

B. Design

The making of this vacuum tool begins with drawing the design of the tool design which will begin with drawing an initial sketch using a pencil on A3 paper, then perfecting it using the help of Solid Work 2017 Software. The design of this tool is depicted in Figures 2 and 3.

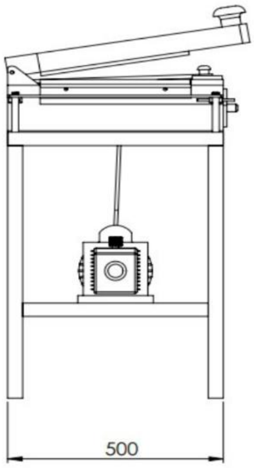

Fig. 2. Front View

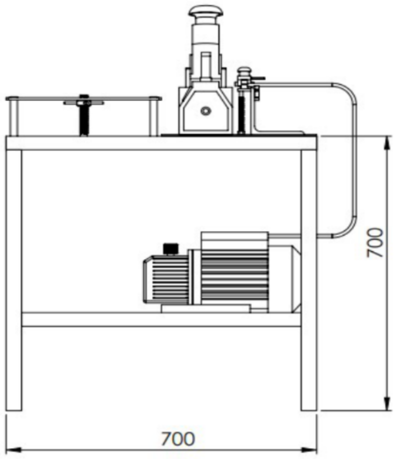

Fig. 3. Side View

C. Working Principle of Vacuum Tool

The principle of how this machine works is a vacuum machine and product packaging specifically designed for processed snakehead fish products to carry out the process of product packaging, especially nugget products by removing air from inside the package using a vacuum pump equipped with sealing/sealing plastic packaging to increase the shelf life use the product and increase the selling value (Rinto et al., 2022). This tool uses a Valve Vacuum Pump Type VE115N with a power of ¼ HP, and uses an impulse sealer tool with a size of 40cm.

D. Components in Vacuum and Packaging Machines

The manufacturing components of this device were refined by solid Work 2017 Software, combining other parts into a single whole, which is listed in Figure 4.

Figure 4 implied that each component of this device had its own function: (1) Vacuum Table: As a place to stand for an impulse sealer, a vacuum clamp that can be adjusted in height; (2) Support Pole: As a table support to keep it parallel and straight against the impulse sealer tool; (3) Adjusters: As a height adjustment device from the table that can be adjusted; (4) Threaded Iron: As an iron tool that can adjust the height of the vacuum tool clamp which can be adjusted; (5) Frame: Its main function is as the main component that carries all the components of this device, made of sturdy iron; (6) Impulse Sealers*:* This tool can perform sealing for plastic packaging; (7) Rubber Sheet*:* A tool that can clamp the end of a plastic package to keep it in the desired position; (8) Iron plate: Supporting rubber sheet tools; (9) On/off Switch*:* Its main function is as an electrical breaker (AC) to the vacuum motor; (10) Stand On/off Switch: As a seat of the breaker and connecting electric current; (11)

Vacuum Pipe: Channelling air from the vacuum motor to the vacuum clamp; and (12) Vacuum Pumps: As a motor for air suction in plastic product packaging.

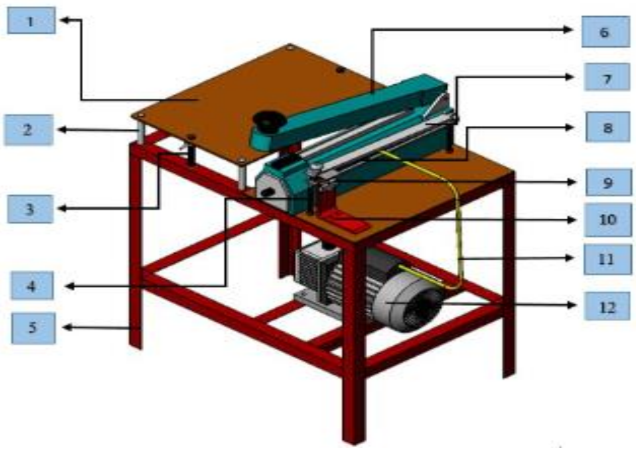

Fig. 4. Components of the Design

III. Results and Discussion

A. Frame Calculation

Calculating the manufacture of the frame aims to carry the supporting components. This frame was then loaded with the tool components.

m. Vacuum = 8kg

P. Frame = 800mm

W = m total × g (1)

= 8kg × 9.81m/s²

= 78.48 N

B. DBB Expense Calculation

The load DBB can be seen in Figure 5.

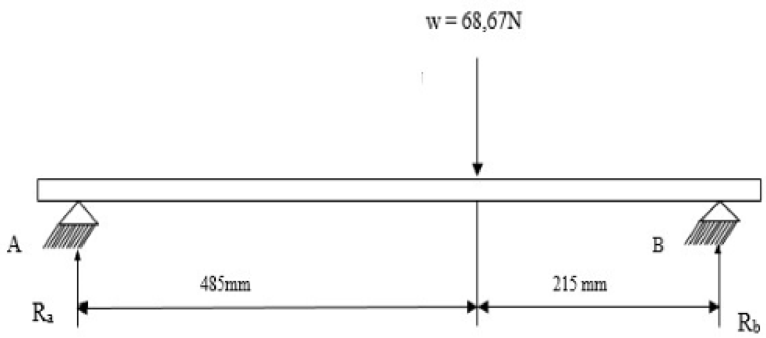

Fig. 5. Free Body Diagram

$\sum$ MA = 0 (2)

-Rb . L + w . L1 = 0 – Rs. 800mm + 78.48N ×485mm = 0

Rb.800 mm = 78.48 N × 485 mm

Rb $= \frac{38{,}062.8\ Nmm}{800\ mm}$

Rb = 47, 5785 N

To find Ra:

$$\sum Fy = 0 + \uparrow \quad (3)$$

$$Ra + Rb - w = 0$$

$$Ra = \frac{w \times L2}{L}$$

$$Ra = \frac{78.48\ N \times 215\ mm}{800mm}$$

$$Ra = \frac{16{,}873.2\ Nmm}{800mm}$$

$$Ra = 21,\ 0915\ N$$

Proof:

$$\sum MA = 0 \quad (4)$$

$$-Rb \cdot L + w \cdot L1 = 0$$

$$-\ 47.5785\ N \times 800mm + 78.48N \times 485\ mm = 0$$

$$-38.062\ Nmm + 38.062\ Nmm = 0$$

$$\sum MA = 0$$

Moment=

$$Mb = Rb \times 215\ mm \quad (5)$$

$$= 47.5785\ N \times 215\ mm$$

$$= 10{,}229{,}3775\ Nmm$$

Obtained bending moment of 10.229.3775 Nmm,

C. DBB Moment of Inertia

The load DBB can be seen in Figure 6.

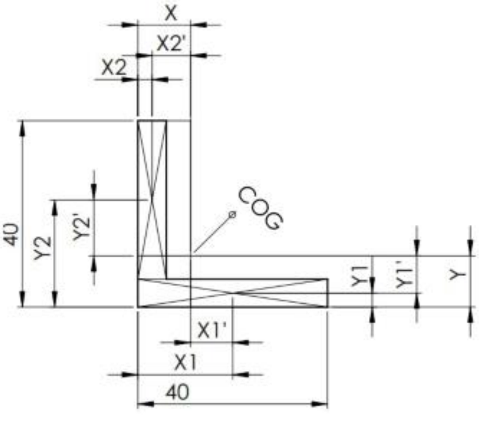

Fig. 6.DBB Moment of Inertia

It is known that:

$X_1 = 20$ mm

$X_2 = 1$ mm

$Y_1 = 1$mm

$Y_2 = 20$ mm

a. Looking for T. Heavy

$$X = \frac{\text{Area 1 . X1 + Area 2 . X2}}{\text{Large1 + Area 2}} \quad (6)$$

$$= \frac{(40 \times 4)\text{mm} \times 2\text{mm} + (38 \times 4)\text{mm} \times 1.5\text{mm}}{120\text{mm}^2 + 11\text{mm}^2}$$

$$= 140\text{mm}^2 + 20\text{mm} + 157\text{mm}^2 \text{ x } 1.5\text{mm}$$

$$= \frac{2800\text{mm}^3 + 166.5\text{mm}^2}{231\text{mm}^2}$$

$$= 11.21 \text{ mm}$$

$$= \frac{L_{.1} \text{ . Y1} + L_{.2} \text{ . Y2}}{L_{.1} + L_{.2}} \quad (7)$$

$$= \frac{(40 \text{ x } 4)\text{mm} \times 1.5\text{mm} + (37 \times 4)\text{mm} \times 21.5\text{mm}}{120\text{mm}^2 + 111\text{mm}^2}$$

$$= \frac{120\text{mm}^2 \text{ x } 20\text{mm} + 111\text{mm}^2 \text{ x } 1.5\text{mm}}{231\text{mm}^2}$$

$$= \frac{2400\text{mm}^3 + 166.5\text{mm}^3}{231\text{mm}^2}$$

$$= 11.11 \text{ mm}$$

D. Calculating Vacuum Time

Calculating the total volume of plastic packaging containing nugget:

$$= p \times l \times t \quad (8)$$

$$= 20 \times 33 \times 1.5 \text{ cm}^3$$

$$= 960\text{cm}^3$$

$$= 0.00096 \text{ m}^3$$

This tool vacuum pump engine is 2 CFM.

$$1\text{CFM} = 1{,}699 \text{ m}^3/\text{h}$$

$$= 2 \text{ CFM} \times 1{,}699\text{m}^3/\text{h}$$

$$= 3.396 \text{ m}^3/\text{h}$$

$$\text{Vacuum time} = \frac{\text{Vacuum chamber volume}}{\text{Vacuum capacity}} \quad (9)$$

$$= \frac{0.00099\text{m}^3}{3{,}396 \text{ m}^3/\text{h}}$$

$$= 0.0002905 \text{ h}$$

$$0.0002905 = \ldots\text{s}$$

$$0.0002905 \times 3600$$

$$= 1.0458 \text{ s}$$

E. Results

The results of the design that has been implemented; the results are obtained in the form of 3D images in Figure 7.

Fig. 7. Vacuum and Packaging Machine

The principle of the results of designing the vacuum machine itself is to remove and expel the air in the food packaging (Susanti et al., 2021) that will wrap the snakehead fish nuggets. This machine operates by sucking all the oxygen in the food packaging simultaneously. Trapped air causes food to expire easily which is caused by bacteria. Sucking all the oxygen that is still in the package is the main goal of this design, after removing the oxygen, this tool will enter the stage of sealing the plastic wrap. Sealing the packaging aims to be sterile from free air.

This study aims to develop a vacuum forming machine that is used today with reference to the Formech 508FS machine design. Benchmarking is done with the consideration that the Formech 508FS engine has a fully integrated system of vacuum, cooling and supporting mechanical systems. The reference to the Formech machine is also expected to provide an alternative system improvement in the design of a new vacuum forming machine, especially in terms of locking the vacuum system and the mechanism for lifting the vacuum table, which is expected to improve the quality of the vacuum forming results when the prototype is realized. The benefits that will be obtained through this research include the realization of a vacuum machine design that suits the needs of SMEs where a vacuum forming process is carried out to produce molds and trays made of rigid sheet plastic. Through this machine design, it is hoped that SMEs can produce new machines that are more reliable so that they can increase the efficiency of plastic raw materials and the speed of production (Munandar & Haidi, 2018), by reducing the number of defective packaging and plastic molds (Yuliati & Widagdo, 2020). The new vacuum forming machine is also expected to be a means of maintaining a competitive advantage for small and medium industries, especially in Yogyakarta and the surrounding areas. This competitive advantage is obtained through a unique form of packaging that is not easy to imitate, considering that the manufacturing process uses CAD/CAM technology. This is necessary considering that one of the main weaknesses of MSMEs is the low level of competition, so that with a packaging model that is not easy to imitate, MSMEs have the opportunity to compete because they have their own characteristics. The establishment of real cooperation between industry players and higher education is also a benefit of this research. The collaboration that is established is through CAD design technology in the design and construction of vacuum forming machines. Also, through this collaboration, universities have the opportunity to develop research that focuses on real industrial problems. The establishment of real cooperation between industry players and higher education is also a benefit of this research. The collaboration that is established is through CAD design technology in the design and construction of vacuum forming machines. Additionally, this collaboration, universities have the opportunity to develop research that focuses on real industrial problems. The establishment of real cooperation between industry players and higher education is also a benefit of this research. The collaboration that is established is through CAD design technology in the design and construction of vacuum forming machines. Also through this collaboration, universities have the opportunity to develop research that focuses on real industrial problems.

IV. Conclusion

Based on the results of the study it can be concluded that the process of designing this vacuum machine produces the following conclusions: (1) The calculation of this machine frame is quite sturdy with a bending stress that is less than the allowable stress; (2) Making the machine design that is designed is not too heavy and takes up a lot of space so that it is easy to operate and also easy to clean; (3) The results of the vacuum time during the trial period, get a result of 1.04s to wrap one product package; dan (4) The use of this vacuum and sealer machine can increase the expiration date of food products and increase the level of product hygiene.

References

Afrinda, S., & Myori, D. E. (2020). Rancang bangun alat vakum kemasan berbasis mikrokontroler ATmega328P. *JTEV (Jurnal Teknik Elektro dan Vokasional)*, *6*(1), 49-56. https://doi.org/10.24036/-jtev.v6i1.107528

Anderson, S., Harfardi, H., Feidihal, F., & Rahmi, F. (2021). Perancangan Mesin Vakum dan Pengemasan untuk Produksi Olahan Jamur Tiram dalam Rangka Meningkatkan Nilai Jual dan Masa Pakai. *Jurnal Teknik Mesin*, *14*(2), 86–93. https://doi.org/10.30630/jtm.14.2.401

Deepa, G. T., Chetti, M. B., Khetagoudar, M. C., & Adavirao, G. M. (2013). Influence of vacuum packaging on seed quality and mineral contents in chilli (Capsicum annuum L.). *Journal of Food Science and Technology*, *50*(1), 153–158. https://doi.org/10.1007/s13197-011-0241-3

Iftadi, I., Jauhari, W. A., & Sumargo, H. P. A. S. (2013). Perancangan Alat Pengemas Vakum untuk Produk Olahan Jamur Tiram dalam Rangka Meningkatkan Nilai Jual dan Masa Pakai. *Performa*, *12*(1), 1–8. https://doi.org/https://doi.org/10.20961/performa.12.1.12644

Kusmini, I. I., Gustiano, R., Prakoso, V. A., & Ath-thar, M. F. (2018). *Budidaya ikan gabus* (B. W. Prasetya (ed.); II). Penebar Swadaya.

Listyanto, N., & Andriyanto, S. (2009). Ikan gabus (Channa striata) manfaat pengembangan dan alternatif teknik budidayanya. *Media Akuakultur*, *4*(1), 18-25.

Munandar, D. A., & Haidi, F. (2018). Rancang bangun mesin vacuum forming. *Seminar Nasional Teknik Mesin Politeknik Negeri Jakarta*, 484–493. http://semnas.mesin.pnj.ac.id/prosiding/2018_pdf/A055.pdf

Nurilmala, M., Safithri, M., Pradita, F. T., & Pertiwi, R. M. (2021). Profil protein ikan gabus (Channa striata), toman (Channa micropeltes), dan betutu (Oxyeleotris marmorata). *Jurnal Pengolahan Hasil Perikanan Indonesia*, *23*(3), 548–557. https://doi.org/10.17844/jphpi.v23i3.33924

Pariyanto, P., Hidayat, T., & Sulaiman, E. (2021). Studi populasi ikan gabus (Channa Striata) di Sungai Air Manna Desa Lembak Kemang Kabupaten Bengkulu Selatan. *DIKSAINS : Jurnal Ilmiah Pendidikan Sains*, *1*(2), 53–60. https://doi.org/10.33369/diksains.1.2.53-60

Rinto, R., Baehaki, A., Yunindyawati, Y., Lestari, S., Ridhowati, S., Widiastuti, I., & Pitayati, P. A. (2022). Introduksi teknologi kemasan vakum serta pendampingan analisis gizi di UMKM Barokah Palembang. *Jurnal Pengabdian Masyarakat Indonesia*, *2*(3), 349–356. https://doi.org/10.52436/1.jpmi.526

Statista Research Department. (2021). *Estimated annual household plastic packaging consumption Indonesia 2020*. https://www.statista.com/statistics/1133357/indonesia-estimated-annual-household-plastic-packaging-usage/

Susanti, S., Bambang, D., & Purbawati, D. L. (2021). Teknologi vacuum sealer nitrogen sebagai optimalisasi produksi olehan kerupuk ikan nila (Krulila) di Desa Gunung Jaya Kecamatan Belik Kabupaten Pemalang. *Inisitif: Jurnal Pengabdian Kepada Masyarakat*, *1*(1), 32–35. https://ejournal2.undip.ac.id/index.php/inisiatif/article/download/13023/6653

Wibisono, B., & Hasibuan, R. P. (2022). Desain cetakan vacuum forming untuk pembuatan plastic packaging tray di PT SM Engineering. *Jurnal Comasie*, *06*(02), 94–106.

Yohana, E., Wibowo, D. B., Jurusan, M., Mesin, T., Teknik, F., Diponegoro, U., Jurusan, D., Mesin, T., Teknik, F., & Diponegoro, U. (2014). Mampu bentuk plastik pada proses vacuum forming dengan variasi tekanan 0.979 Bar, 0.959 Bar, 0.929 Bar, 0.909 Bar pada temperatur 200^{o}C. *Jurnal Teknik Mesin*, *2*(2), 120–128.

Yuliati, S., & Widagdo, T. (2020). Teknologi Vacum Frying untuk Penggorengan Keripik Jamur Tiram Di Desa Talang Bubuk Plaju Palembang. *Jurnal Pengabdian pada Masyarakat*, *3*, 38–44. http://jurnal.polsri.ac.id/index.php/aptekmas/article/view/1932%0Ahttps://jurnal.polsri.ac.id/index.php/aptekmas/article/download/1932/948