

**PERFORMANCE EVALUATION OF CENTRAL LUZON STATE  
UNIVERSITY(CLSU) SUNFLOWER OIL EXTRACTOR**

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## **ABSTRACT**

**Sta.Ana, Kyla Audrey S.**, Department of Agricultural and Biosystems Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, June 2023,  
**PERFORMANCE EVALUATION OF CLSU-CENTRAL LUZON STATE UNIVERSITY (CLSU) SUNFLOWER OIL EXTRACTOR**

**Adviser: John Vincent A. Nate, M.Sc.**

The sunflower industry in the Philippines has been relatively limited due to various factors. To address this, CLSU has developed sunflower processing methods, encompassing irrigation, threshing, dehulling, and oil extraction. Specifically, CLSU has created a sunflower oil extractor for cold-pressed oil extraction. This study evaluated the performance of the CLSU Sunflower Oil Extractor in terms of its Input Capacity, Throughput Capacity, Oil Extraction Efficiency, Oil Extraction Losses, Oil Extraction Recovery, and Cost. The evaluation revealed that lower rpm resulted in higher oil yield, reduced extraction losses, and improved machine efficiency. Significant differences were observed when testing the machine at 30, 35, and 40 rpm. The highest throughput was achieved at the lowest rpm, processing 6.089 kg/hr of unrefined oil at 30 rpm and 2.90 kg/hr at 40 rpm. Thus, 30 rpm was determined to be the optimal rotational speed for maximum throughput. Regarding oil extraction recovery, rates of 22.17%, 17.17%, and 12.83% were achieved at 30, 35, and 40 rpm, respectively. The lowest rpm demonstrated the highest oil recovery. Different rpm values also affected oil extraction efficiency, with rates of 67.17%, 52.02%, and 38.89% at 30, 35, and 40 rpm, respectively. The lowest rpm yielded the highest efficiency. Oil extraction losses were found to be 32.83%, 47.98%, and 61.11% at 30, 35, and 40 rpm, respectively. Maximum rpm resulted in the greatest loss, while the minimum rpm exhibited the least. Regarding the cost, according to CLSU-CRDDC, the CLSU Sunflower Oil Extractor is priced at 37,274.00 PH

## LITERATURE CITED

- Abdel-Rahim, G.A. and Mahmoud, G.I. (2011). Protective effects of wheat germ rich diet against the toxic influence of profenofos on rat tissue lipids and oxidative pentose phosphate shunt enzymes. *Grasas Y Aceites*, 62(3). DOI: 10.3989/gya.125810
- Arişanu, A.O. (2013). Mechanical continuous oil expression from oilseeds: oil yield and press capacity. *5<sup>th</sup> International Conference: Computational Mechanics and Virtual Engineering*.
- Bakker-Arkema, F.W., DeBaerdemaeker, J., Amirante, P., Ruiz-Altisent, M., and Studman, C.J. (1999). Front matter and index. *CIGR Handbook of Agricultural Engineering*, 4.
- Bamgboye, A.I. and Adejumo, A.O.D. (2007). Development of a sunflower oil expeller. *Agricultural Engineering International: The CIGR E-journal*, 6(15).
- Baryeh, E.A. (2000). Effects of palm oil processing parameters in yield. *Journal of Food Engineering*, 48(2001).
- Bäumler, E.R., Carrín, M.E., and Carelli, A.A. (2016). Extraction of sunflower oil using ethanol as solvent. *Journal of Food Engineering*. doi: 10.1016/j.jfoodeng.2016.01.020.
- Brăţfălean, D., Cristea, V.M., Agachi, P.S., and Irimie, D.F. (2017). Improvement of sunflower oil extraction by modelling and simulation. *Revue Roumaine de Chimie*, 53(9).
- Bravi, M., Bubbico, R., Manna, F., and Verdone, N. (2002). Process optimisation in sunflower oil extraction by supercritical CO<sub>2</sub>. *Chemical Engineering Science*, 57(2002).
- Cassel, E., Vargas, R.M.F., Martinez, N., Lorenzo, D., and Dellacassa, E. (2008). Steam distillation modelling for essential oil extraction process. *Industrial Crops and Products*, 29(2009). doi:10.1016/j.indcrop.2008.04.017
- de Aquino, D.S., Fanhani, A., Stevanato, N., and da Silva, C. (2019). Sunflower oil from enzymatic aqueous extraction process: maximization of free oil yield and oil characterization. *Journal of Food Process Engineering*. DOI: 10.1111/jfpe.13169
- Espino, M.T.M., de Ramos, R.M.Q., Bellotindos, L.M. (2019). Life cycle assessment of the oil palm production in the Philippines: a cradle to gate approach. *Nature Environment and Pollution Technology*, 18(3).
- Fernández-Martínez, J.M., Pérez-Vich, B., and Velasco, L. (2009). Sunflower. *Handbook of Plant Breeding*, 4. DOI: 10.1007/978-0-387-77594-4\_6

- Grompone, M.A. (2011). *Sunflower oil. Vegetable Oils in Food Technology: Composition, Properties and Uses*, 2.
- Gui, M.M., Lee, K.T., and Bhatia, S. (2008). Feasibility of edible oil vs. non-edible vs. waste edible oil as biodiesel feedstock. *Energy*, 33. doi:10.1016/j.energy.2008.06.002
- Jacobsen, L.A. and Backer, L.F. (1986). Recovery of sunflower oil with a small screw expeller. *Energy in Agriculture*, 5.
- Kartika, I.A., Pontalier, P.Y., and Rigal, L. (2005). Extraction of sunflower oil by twin screw extruder: screw configuration and operating condition effects. *Bioresource Technology*, 97. doi:10.1016/j.biortech.2005.10.034
- Khan, L.M. and Hanna, M.A. (1983). Expression of oil from oilseeds: a review. *J. agric. Engng Res*, 28.
- Kumar, C.R., Benal, M.M., Prasad, B.D., Krupashankara, M.S., Kulkarni, R.S., and Siddaligaswamy, N.H. (2016). Microwave assisted extraction of oil from pongamia pinnata seeds. *Materials Today: Proceedings*, 5(2015).
- Lamas, D.L., Constenla, D.T., and Raab, D. (2016). Effect of degumming process on physiochemical properties of sunflower oil. *Biocatalysis and Agricultural Biotechnology*. <http://dx.doi.org/10.1016/j.bcab.2016.03.007>
- Larsen, R.K., Dimaano, F.R., and Pido, M.D. (2018). Can wrongs be righted? Prospects for remedy in the Philippine oil palm agro-industry. *Development and Change*, 00(0). DOI: 10.1111/dech.12416
- Lawson, H. (1995). Sources of oils and fats. *Food Oils and Fats*.
- Matthäus, B. (2008). Chapter 2: oil technology. *Technological Innovations in Major World Oil Crops*, 2. DOI: 10.1007/978-1-4614-0827-7\_2.
- Melo, E., Michels, F., Arakaki, D., Lima, N., Goncalves, D., Cavalheiro, L., Oliveira, L., Caires, A., Hiane, P., and Nascimento, V. (2019). First Study on the Oxidative Stability and Elemental Analysis of Babassu (*Attalea speciosa*) Edible Oil Produced in Brazil Using a Domestic Extraction Machine. *Molecules*, 24(4235). doi:10.3390/molecules24234235
- Mmongoyo, J.A., Wu, F., Linz, J.E., Nair, M.G., Mugula, J.K., Tempelman, R.J., Strasburg, G.M. (2017). Aflatoxin levels in sunflower seeds and cakes collected from micro- and small-scale sunflower oil processors in Tanzania. *PLoS ONE*, 12(4). <https://doi.org/10.1371/journal.pone.0175801>

- Nadeem, R., Shahid, S.A., and Iabal, A. (2015). Effect of cold-pressing and Soxhlet extraction on the Physico-chemical attributes of sunflower (*Helianthus annuus*L.) seed oil. *International Journal of Chemical and Biochemical Sciences*, 7(2015). <https://www.researchgate.net/publication/323496709>
- Narayana, T., Kaimal, B., Vali, S.R., Surya, B.V., Rao, K., Chakrabarti, P.P., Vijayalakshmi, P., Kale, V., Narayana, K., Rani, P., Rajamma, O., Bhaskar, P.S., and Rao, T.C. (2002). Origin of problems encountered in rice bran oil processing. *Eur. J. Lipid Sci. Technol.*, 2014(2002).
- Omran, A. (1989). Oil crops: sesame and sunflower subnetworks. *Proceedings of the Joint Second Workshop*.
- Pal, U.S., Patra, R.K., Sahoo, N.R., and Bakhara, C.K. (2014). Effect of refining on quality and composition of sunflower oil. *Journal of Food Science Technology*. DOI 10.1007/s13197-014-1461-0
- Pojić, M., Misan, A., Sakac, M., Hadnadev, T.D., Saric, B., Milovanovic, I., and Hadnadev, M. (2014). Characterization of byproducts originating from hemp oil processing. *Journal of Agricultural and Food Chemistry*, 62. [dx.doi.org/10.1021/jf5044426](https://doi.org/10.1021/jf5044426)
- Rab, M., Schein, C., and Matthäus, B. (2008). Virgin sunflower oil. *Eur. J. Lipid Sci. Technol.*, 110. DOI: 10.1002/ejlt.200800049
- Romanić, R. (2020). Cold pressed sunflower (*Helianthus annuus* L.) oil. *Cold Pressed Oils*. <https://doi.org/10.1016/B978-0-12-818188-1.00017-7>
- San Juan, L.D. and Villamide, M.J. (2010). Nutritional evaluation of sunflower seed and products derived from them: effects of oil extraction. *British Poultry Science*, 41(2). <https://doi.org/10.1080/713654913>
- Sangameshwara, G.S. and Ravaikiran, B.S. (2015). Design and fabrication of portable virgin coconut oil extracting machine. *International Journal of Engineering Research and General Science*, 3(4).
- Shukla, B.D., Srivastava, P.K., and Gupta, R.K. (1992). Oil processing technology. *Technology Mission on Oilseeds*.
- Uziak, J. and Loukanov, I.A. (2007). Performance evaluation of commonly used oil ram press machine. *Agricultural Engineering International: The CIGR E-journal*, 7(19).
- Villareal, R.L. (1989). Industrializing the Philippine countryside: some prospects and possibilities. *Transactions of the National Academy of Science and Technology* Zhao, X., Wei, L., and Julson, J. (2014). First stage of bio-jet fuel production: non-food sunflower oil extraction using cold press method. *IMS Energy*, 2(2). DOI:

10.3934/energy.2014.2.193

Zhao, X., Wei, L., and Julson, J. (2014). First stage of bio-jet **fuel production**: non-food sunflower oil extraction using cold press method. *IMS Energy*, 2(2). DOI: 10.3934/energy.2014.2.193