A VACUUM FRYER FOR "GREENSHELL" MUSSELS MEAT

by

Alexis T. Belonio

Project Director

Appropriate Technology Center

Department of Agricultural Engineering and Environmental Management

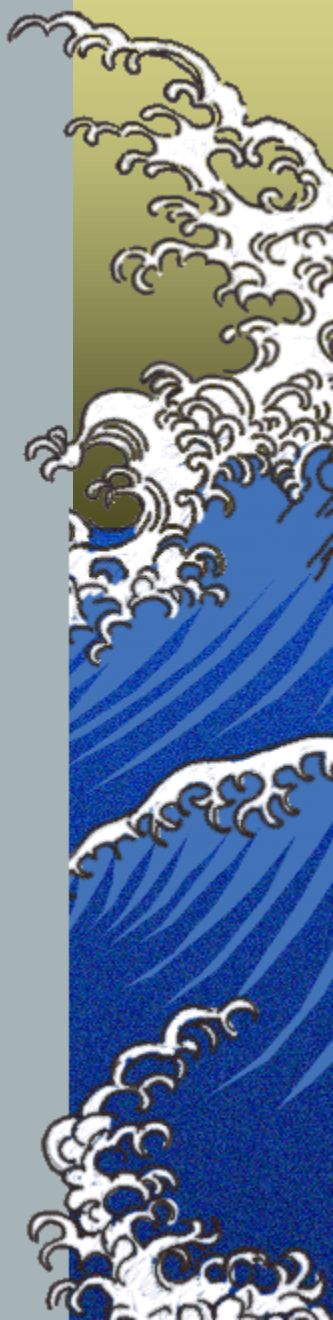
Central Philippine University

Iloilo City

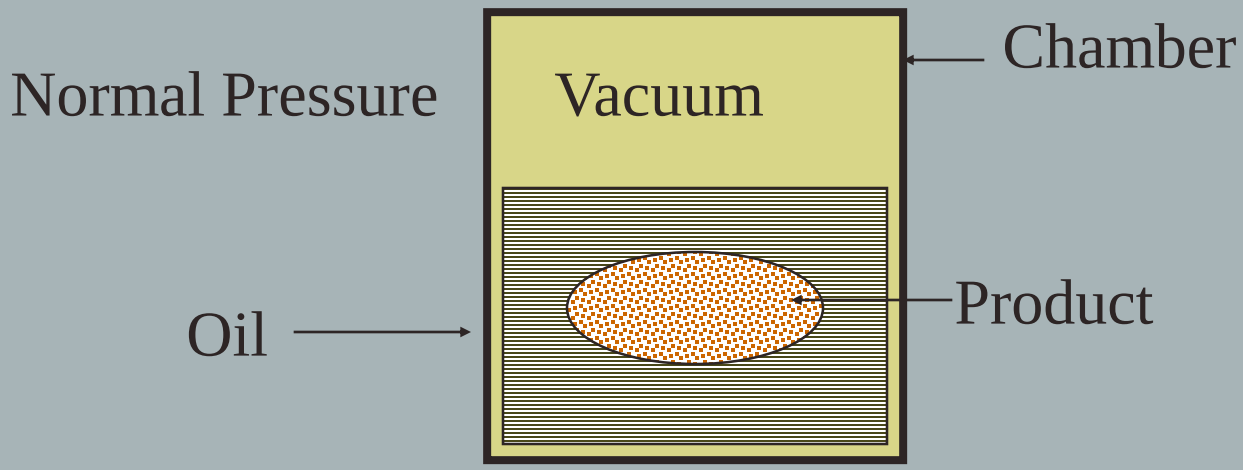
atbelonio@yahoo.com

Introduction

- *Vacuum frying is a recently developed technology in frying foods.*
- *It is adopted mainly in western countries like USA and Europe to obtain good quality fried food.*



- *The method basically is done by subjecting the product to be fried into a deep oil below atmospheric pressure. Hence, product can be fried below the smoke point temperature of an oil.*



- *Its advantages are as follows:*
  - *The freshness of the flavor is retained in the final product*
  - *There is less shrinkage in the textural characteristics of the product*
  - *There is less depletion of nutrient in the product*
  - *The smoke point of frying oil can be avoided during frying operation*
  - *The frying time is much shorter*
  - *The consumption of oil is lesser during frying*

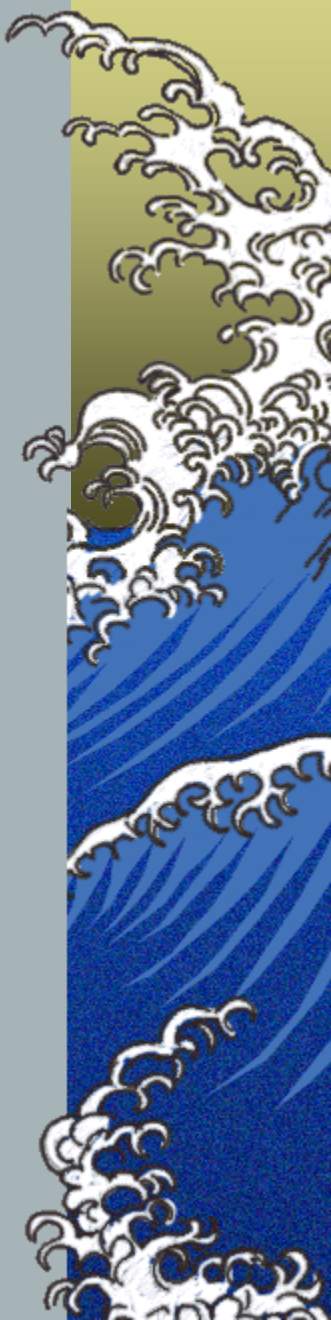
- *The only disadvantage is:*
  - *The investment cost for the vacuum fryer is high since the technology need to be imported or if fabricated locally two of its important parts are very expensive.*

The Vacuum Fryer

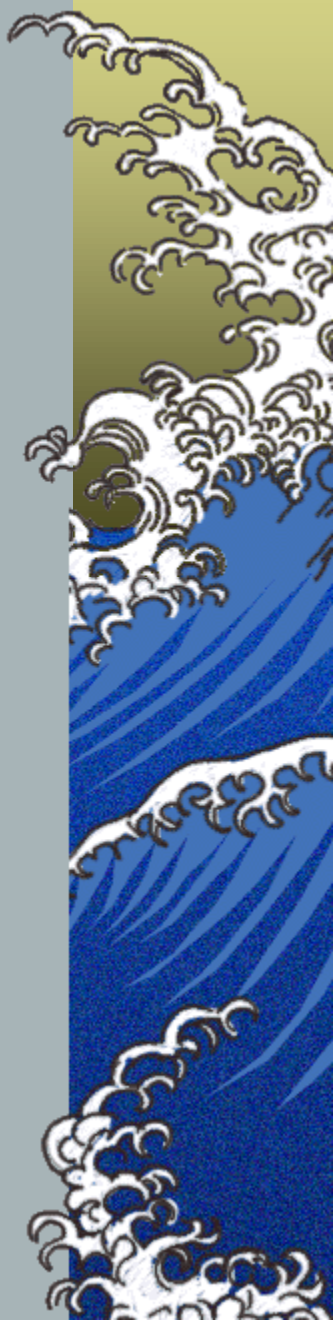
Vacuum pump

Background

- *1998 – Research and development on vacuum fryer was started at CPUCA in collaboration with the private manufacturer and the Bureau of Fishery and Aquatic Resources Region VI for frying squid ring.*



- *2002 – Improvement and localization of machine parts were carried out in collaboration with AMMARO for frying "Greenshell" mussels meat.*

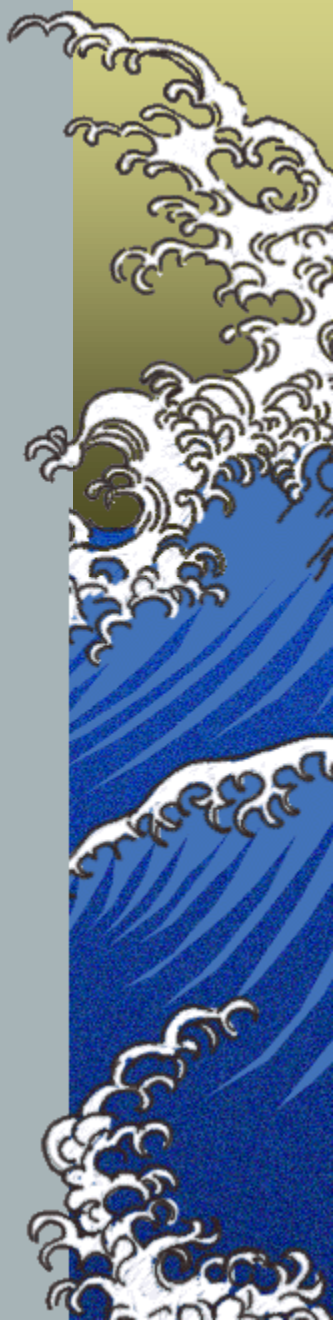


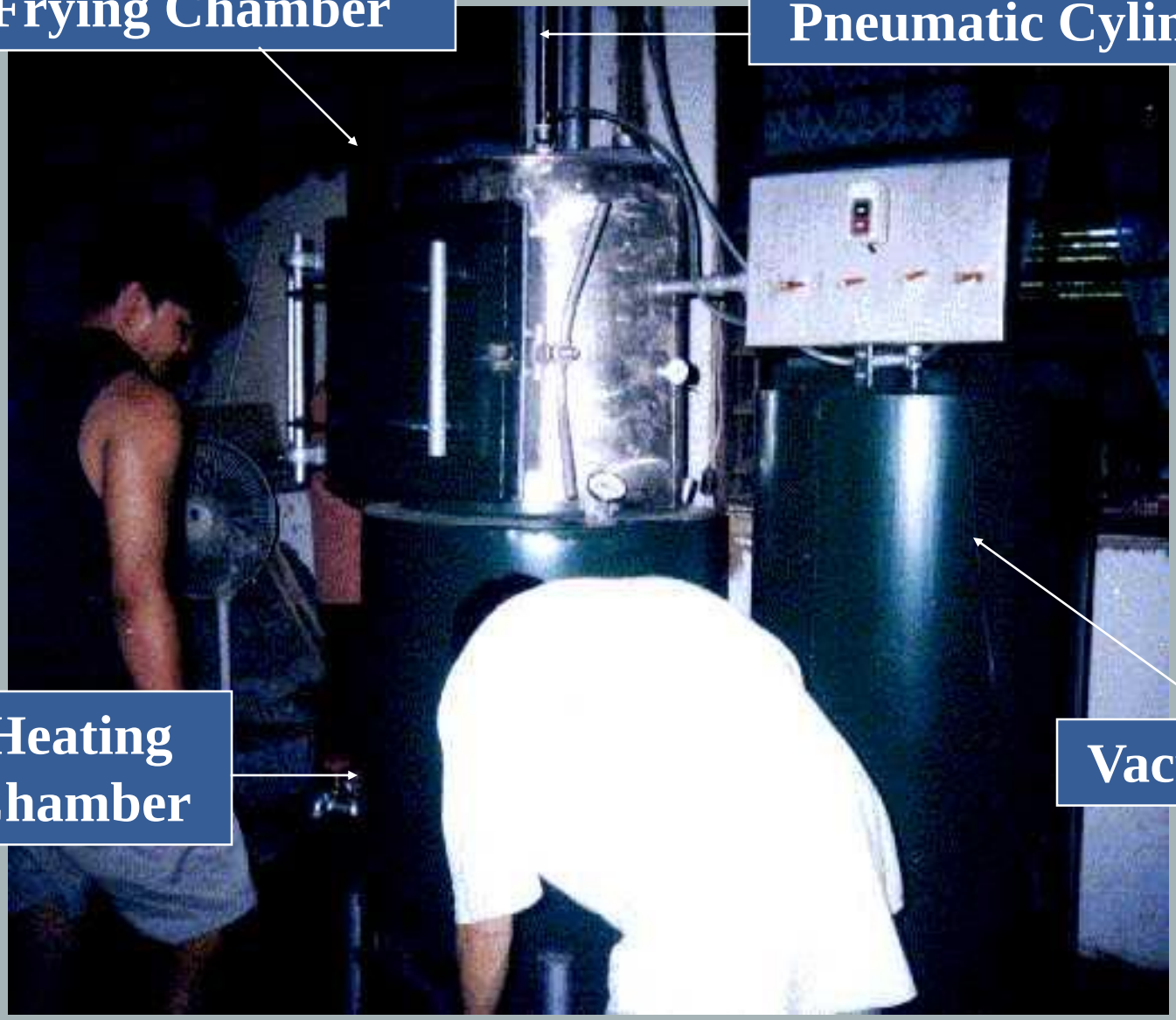
- *2003 – Laboratory vacuum fryer was fabricated to explore its potential for frying other products such as potato, sweet potato, sliced banana, chicken, etc.*

Vacuum Tanks

Frying Chamber

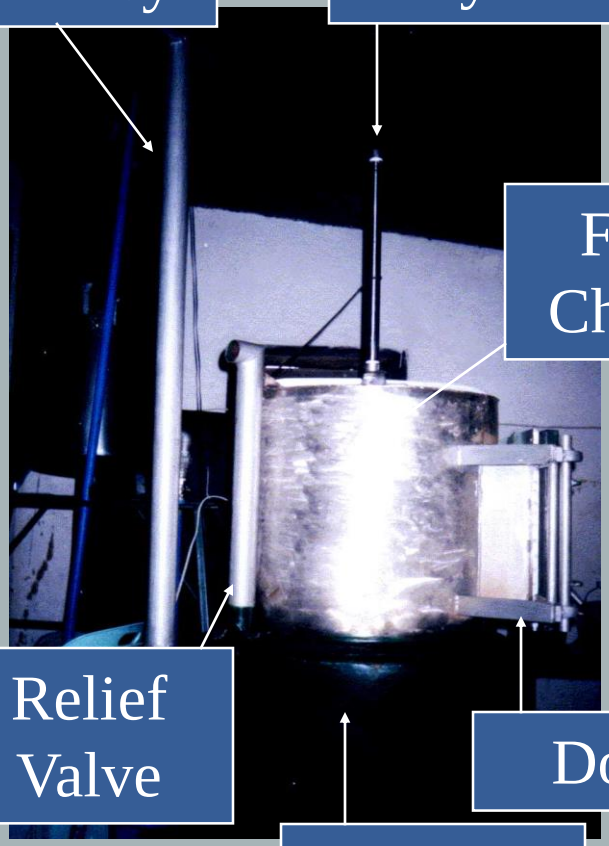
THE TECHNOLOGY



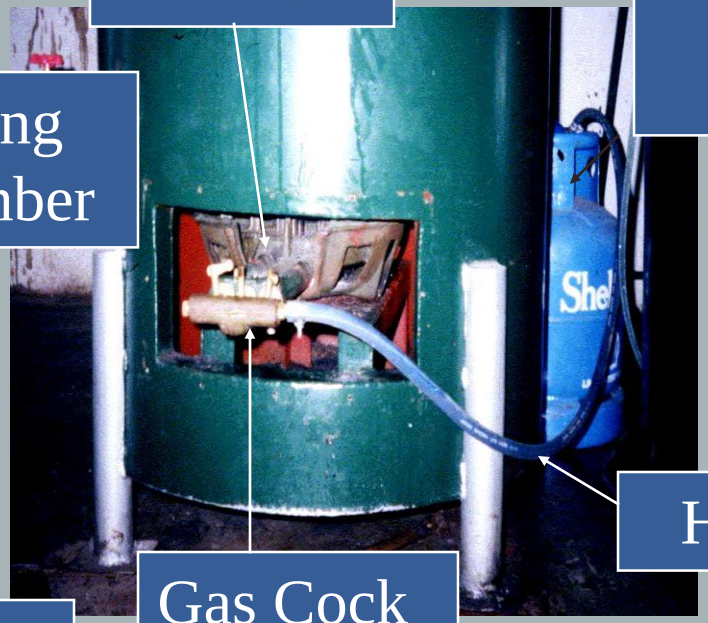


The Vacuum Fryer


Chimney
Air Compressor
LPG Burner
LPG Tank
Water Pump



The Frying and Heating Chamber Assemblies



The Burner Assembly

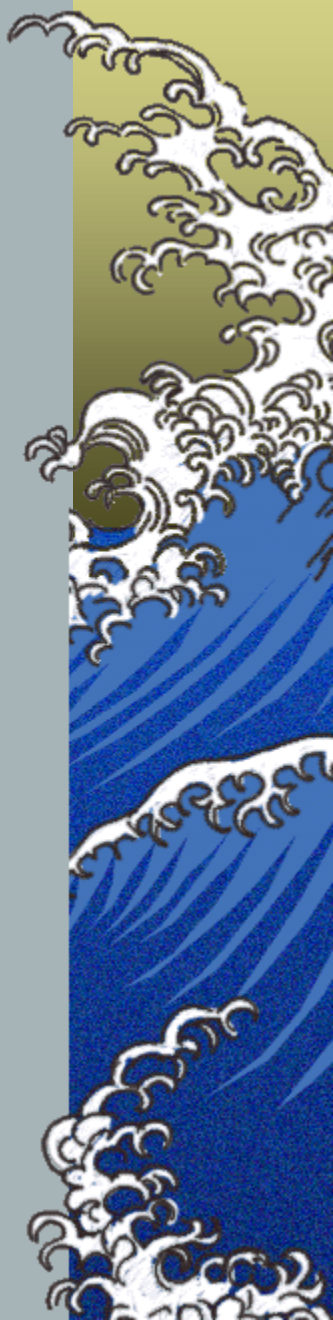
Design Specification

Frying Chamber	*0.6mϕ x 1.2mH – SS plate 1/8 in thck*
Heating Chamber	*0.8mϕ x 0.7mH – SS plate 1/8 in thck*
No. of Frying Basket	*2 units stainless steel screen ¼ in. mesh*
Vacuum Tank	*2 units 0.6m ϕ x 1.22 mH-1/8in.thck MSplate*
Pump	*¾ hp Pedrollo pump*
Water Tank	*82 gallon capacity*
Burner	*3-burner LPG burner with 11 kg tank*
Air Compressor	*¼ hp VESPA Air compressor*
Pneumatic Cylinder	*1-in.ϕ x 0.6 m SS pipe*

Fabrication of the Machine

Inspection of the Machine

OPERATION



Sample Preparation

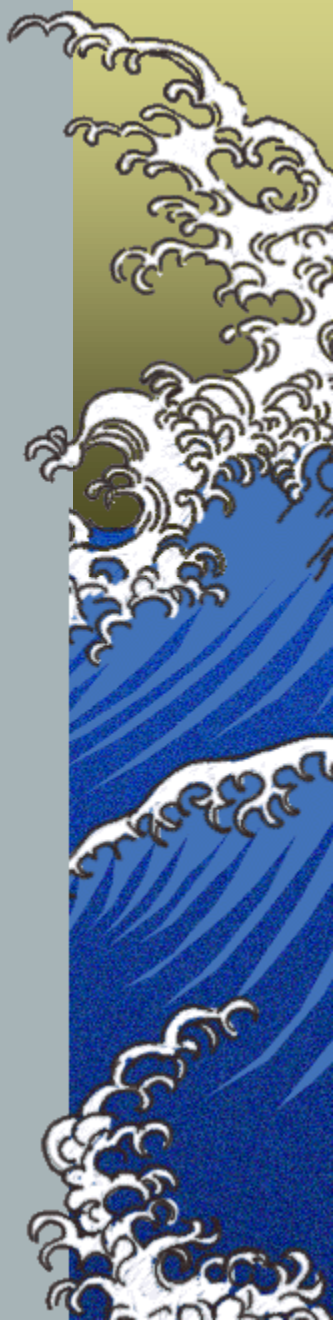
Cleaning of Greenshells

↓

Boiling of Greenshells

↓

Separating Meat from Shells



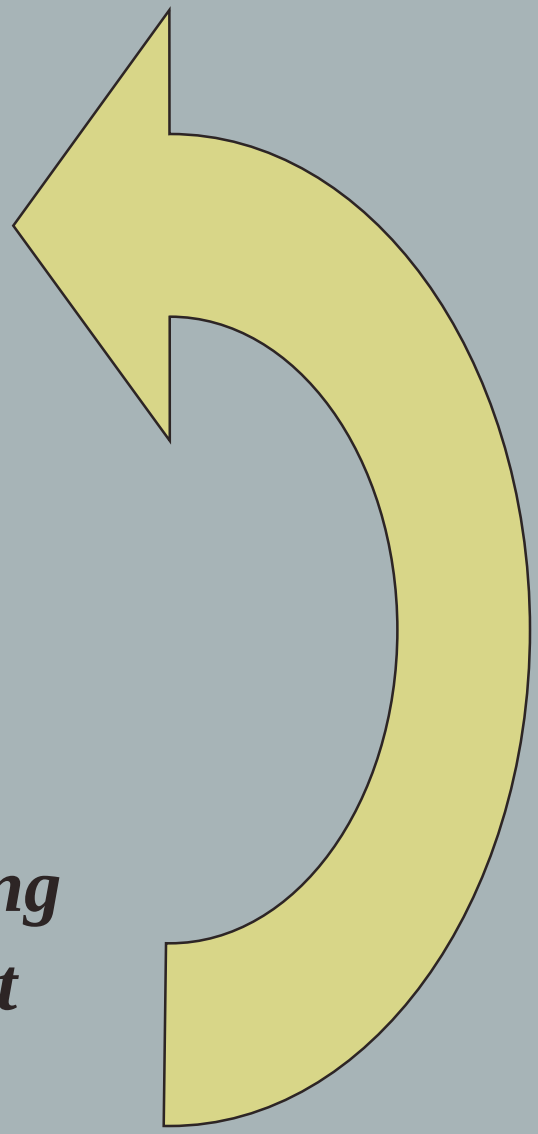
Cleaning and separating different sizes of shell

Heating the green shell into a boiling water for about 5 minutes

Removing and separating the meat from the shell

Machine Operation

- ***Cleaning the Machine***
- ***Filling of Oil***
- ***Heating of oil***
- ***Pumping Water***
- ***Loading of Product***
- ***Pneumatically Dipping of Product***
- ***Vacuum Generation and frying***
- ***Removal of the Fried Product***



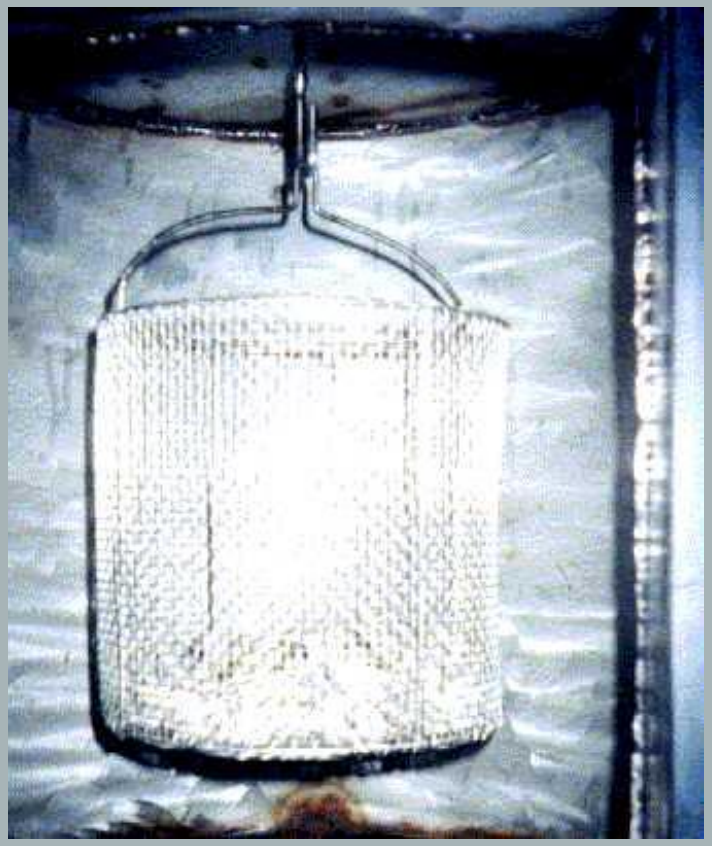
Preparation of the Fryer for Operation

Loading of Frying Oil

Loading of Heating Oil

OIL USED FOR VACUUM FRYER

Loading of
“greenshell”
in the basket



The basket
inside the
frying chamber

Operating Condition

Parameter	*Run 1*	*Run 2*	*Run 3*
Frying Oil Temperature	*135 C*	*119 C*	*129 C*
Heating Oil Temperature	*155 C*	*138 C*	*154 C*
Vacuum Gauge pressure	*15 in HG*	*13 in Hg*	*14 in Hg*
Dipping Time	*5 min*	*5 min*	*6 min*
Initial Weight of Samples	*1 kg*	*2 kg*	*1.75 kg*
Final Weight of Samples	*0.35 kg*	*0.65 kg*	*0.50 kg*
Physical Appearance of Sample After Frying	*Crispy, less oil, good taste and odor*	*Crispy, slightly oily, good taste and odor*	*Crispy, less oil, good taste and odor*

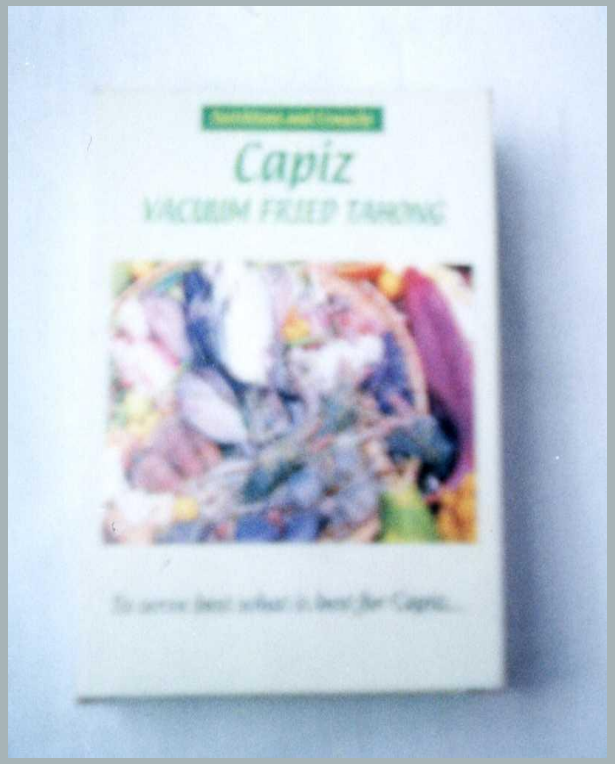
**At 60 liters heating oil and 160 liters frying oil*

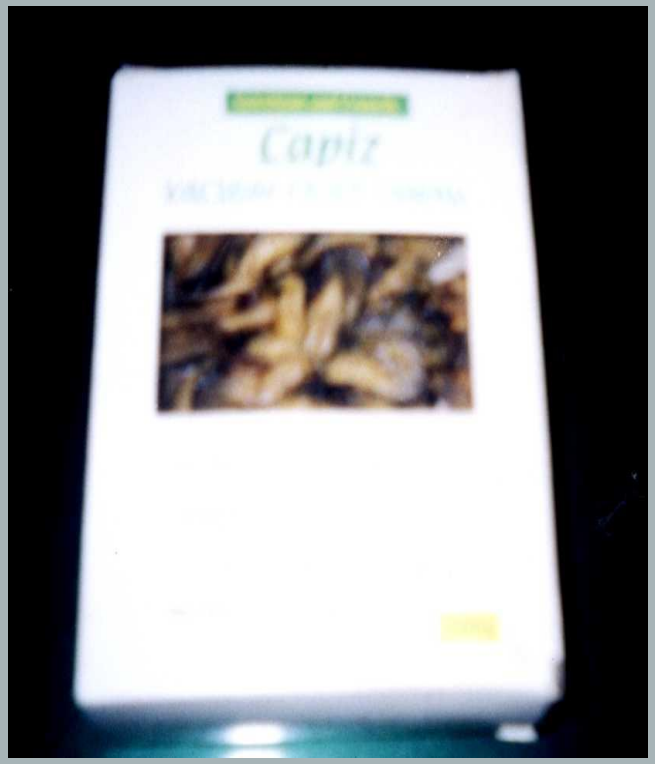
Operating Performance

Run	*Frying Capacity (kg/load)*	*Frying Recovery (%)*	*Oil/Product Ratio* (dmls)*	*Electrical Power Input (kW)*	*Fuel consumption/load (kg LPG/load)*
1	*1.00*	*35.00*	*156.8*	*1.25*	*0.90*
2	*2.00*	*32.50*	*78.3*	*1.02*	*1.10*
3	*1.25*	*28.60*	*125.4*	*1.54*	*1.20*
Ave	*1.42*	*32.03*	*120.2*	*1.27*	*1.06*

**Coconut oil density = 0.923 kg/liter*

Sample Products Before and After Frying





Sample Products for Export

Operating Cost Analysis

Investment cost	*P205,000.00*
Fixed Cost	*P/day*
Depreciation 1/	*72.21*
Interest on Investment 2/	*134.79*
Repair and Maintenance 3/	*56.16*
Insurance 4/	*16.85*
Total	*279.98*
Variable Cost	*P/day*
Fuel 5/	*160.00*
Labor 6/	*400.00*
Electricity 7/	*60.96*
Oil 8/	*1,080.00*
Total	*1,700.96*
Total Cost	*P1,980.94 per day*
Frying Capacity 9/	*15.36 kgs per day*
Operating Cost	*P129.96 per day*

1/ Straight line method at 10% salvage value and 7 years life span

2/ 24% of IC

3/ 10% of IC

4/ 3% of IC

5/ P320 per tank

6/ Two laborers at P200 per day at 8 hours per day

7/ Electric load at 1.27 kW for 8 hours at P6 per kW-hr

8/ P30 per liter of oil at 180 liters per week

9/ At 32% product recovery

Cost-Return Analysis

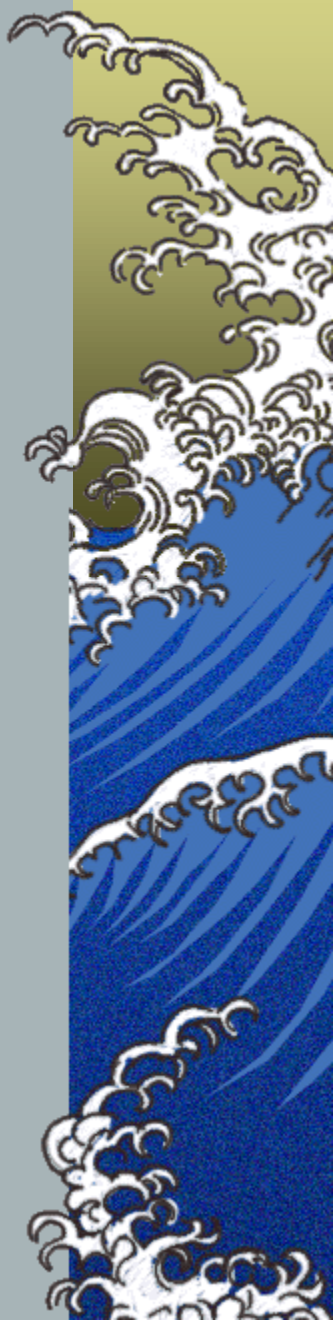
Investment Cost	*P205,000.00*
Fixed Cost	*279.98*
Variable Cost	*1,700.96*
Total Operating Cost	*1,980.94*
Net Income	*508,253.18*
Return on Investment	*247.9%*
Payback Period	*0.403 year*
Benefit Cost Ratio	*4.27*

Assumptions:

1. ***Operating period per year is 20 days/month for 3 months***
2. ***Cost of "Greenshell" mussels per sack is P150 at 8 kg meat output per sack***
3. ***Export price of vacuum fried "Greenshell" mussels meat is P700 per kg***

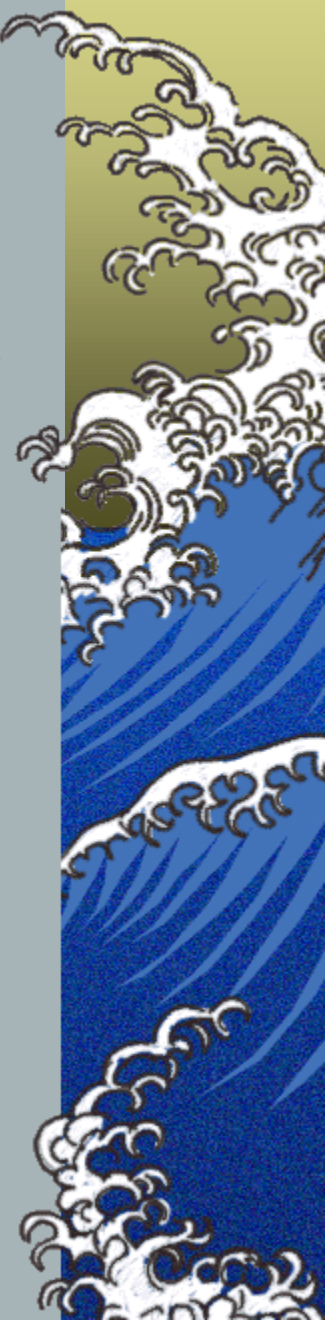
Minimum Requirement for Adaptability

- *User: Cooperatives, Entrepreneurs, individual businessman who are selling fried products*



Social and Economic Impact

- *Availability of local technology in the market for vacuum frying of products*
- *Income generating project for cooperatives, entrepreneurs, and businessmen*
- *Employment for the local people who will fabricate and use the technology*
- *Additional income for manufacturers and fabricators*
- *Cost reduction to investors due to local fabrication of pneumatic cylinders and use of local control valves as well as due to the adoption of water pump and two vacuum tanks*

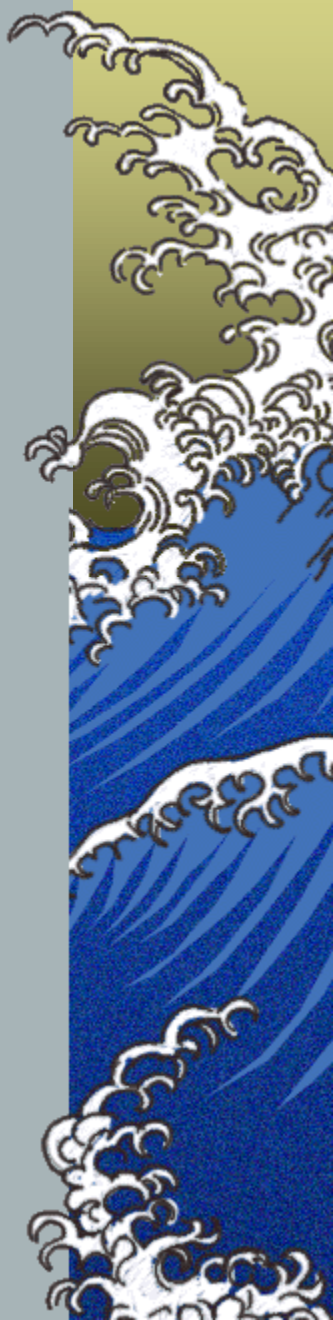


Vacuum Pump @ PHP65,000 excluding shipment from US

Water pump @ PHP3,000 locally available + two water tanks @ PHP10,000 each

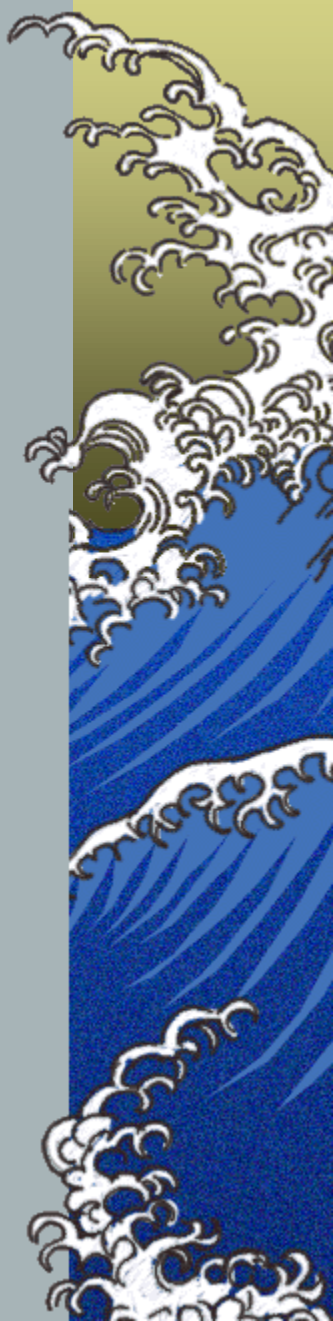
Support System Requirements

- *Promotion and dissemination*
- *Training on construction and operation to potential adaptors of the technology*
- *Training on food processing operation using other similar products*



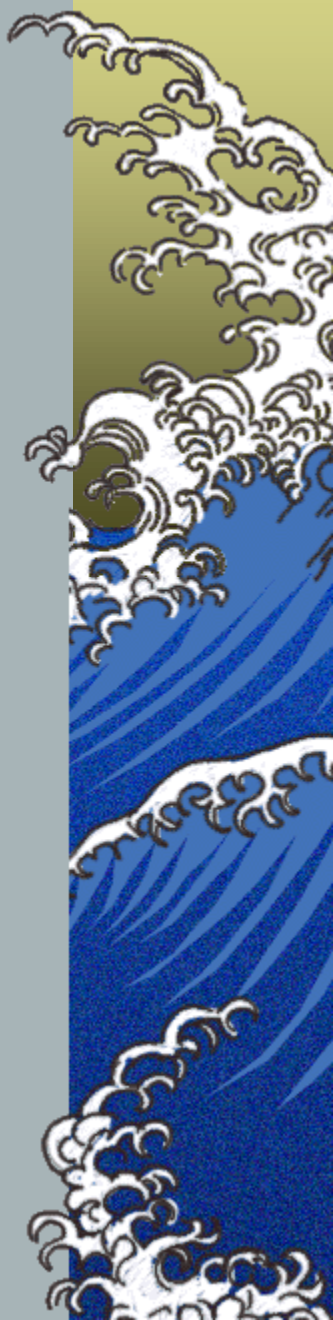
Environmental Impact

- *Free from emission of gases since the technology do not use biomass or liquid fuel*
- *Excess harvest of "Greenshells" can be converted to saleable product rather than disposing them as waste and pollutes the environment*
- *Use oil during processing can be recycled for use as preheating oil for the fryer.*

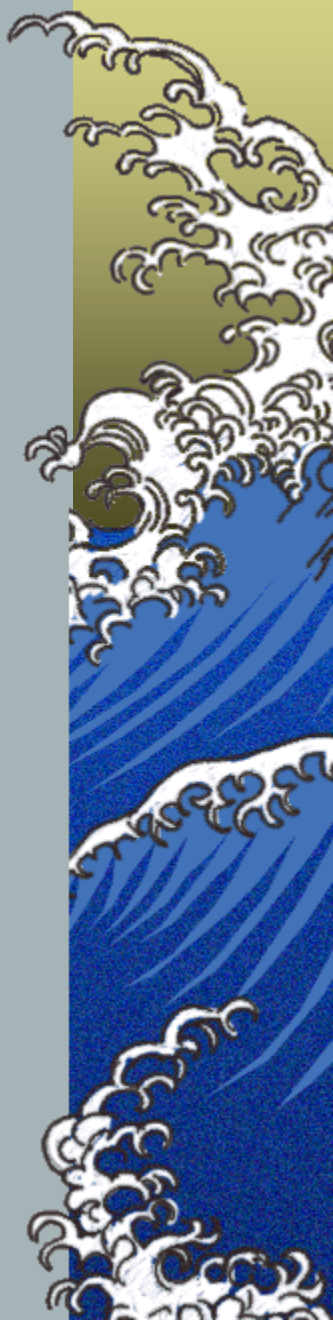


Advantages of the Technology

- *Low investment cost – very minimal parts are imported*
- *Fabrication can be done locally even in small backyard shop*
- *Easy to operate – operation can be done using push button switches and ball valves*
- *Low maintenance requirement because the use of water pump can tolerate high temperature and moisture conditions that often confronted with the vacuum pump*

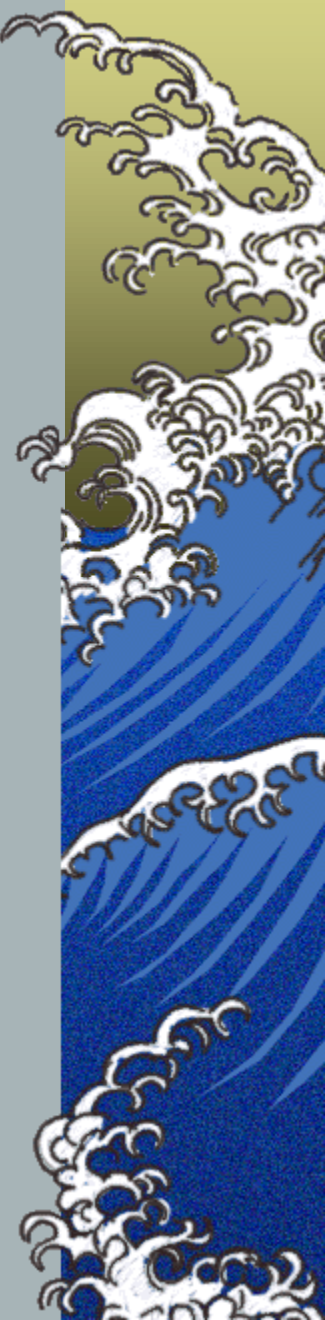


- *The machine can be further size up or down depending on the need of the user. It can also be further reduce its cost and operation made easier by adopting electric heater rather than the gas heater.*
- *Vacuum fried product can reduce cholesterol problem and improve health and living condition of the people*



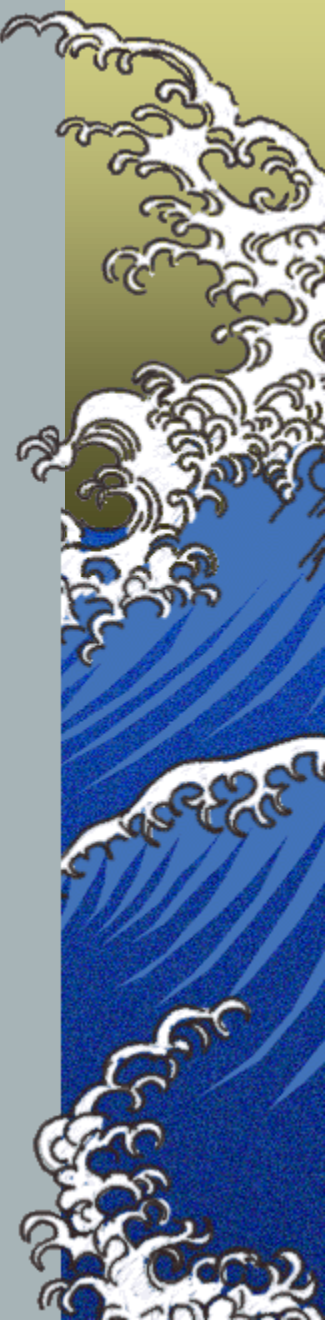
Limitation of Technology

- *Suitable for selected kinds of product*
- *Sizing is required when larger or smaller capacity is needed*
- *Operating condition should properly be set to achieve quality result*
- *There is a need to select the kind of oil for frying if best quality of fried product is needed*



Dysfunctional Consequences of the Technology

- *Reduce performance and quality of product when over fed*
- *Product quality will be affected when in appropriate frying temperature and pressure will be used during operation.*

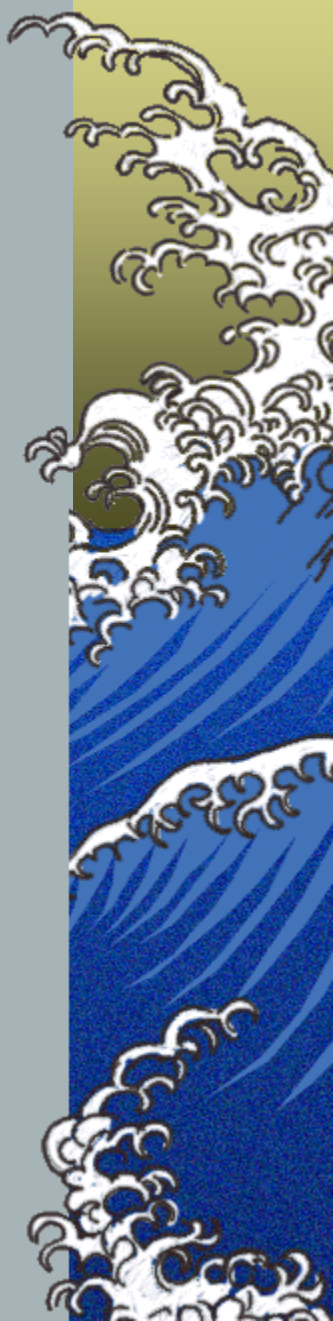


Source of Technology

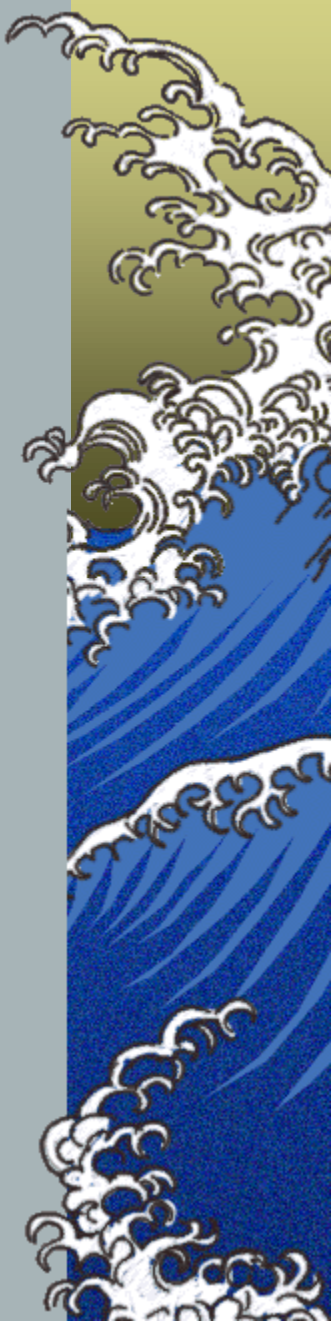
Title of Research	*Design and Development of Vacuum Fryer for Frying Food products*
Duration	*6 years*
Organization	*Appropriate Technology Center, Department of Agricultural Engineering and Environmental Management, College of Agriculture, Central Philippine University, Iloilo City*
Collaborating Organization	*BFAR Region VI, DOST-PSC Capiz, AMMARO-Roxas City, Jamandre Industry, Inc., CPU-URC, and CPU-DHS*
Researcher	*Engr. Alexis T. Belonio*

References

- *Akoh, C and A. Estes Reynolds. Extending the Quality of Utilization of Frying OIls and Improving the Quality of Fried Foods. Project No. FP98-PC03. The University of Georgia.*
- *Frying Method Researched at Texas A&M. Food Service Industry News. http://www.foodservice.com/news_homepage_expandtitle_fromhome.cfm?passid=1671.*
- *Kawas, M. L. and R. G. Moreira. Oil Absorption During Frying and Cooling as Affected by Operating Conditions and Raw Material Properties. Agricultural Engineering, Texas A & M University, 2117, Scoates Hall, 314-A, College Station, TX 77842. http://www.confex.com/ift/99annual/abstracts/4016.htm*
- *Krupanyamat, V. and S. Brumiratana. Effect of Operating Condition on Product Quality of Vegetable Vacuum Frying. http://www.kmutt.ac.th/organization/Engineering/Food/t011y94.html.*



- *Oil Smoke Points. (htpp://www.goodeatsfanpage.com/collectedinfo/oilsmoke point.htm)*
- *Moreira, R. G. amd J. Garayo. Vacuum Frying of Potato Chips. Biological & Agricultural Engineering. Texas A & M University, 310 Scoates Hall. College Station, TX 77843-2117. http://ift.confex.com/ift/2002/techprogram/paper_10613.htm.*
- *Velez-Ruiz, J. F., M. E. Sosa-Morales, F. T. Vergara-Balderas, and J. Xique-Hernandez. Effect of Oil Temperature on Heat and Mass Transfer of Chicken Strips During Frying Process. Chemical and Food Engineering. University de las Americas-Puebla, Sta. Catarina Martir, Cholula, Puebla 72820, Mexico. http://www.confex.com/ift/99annual/abstracts/3865.htm.*
- *Yan, B. B. and M. Y. Chen. Effect of Microwave Assisted Deep-Fat Frying on the oil Adsorption of Instant Noodles. Thermal Process Engineering Group, Food Industry Research & Development Institute, 331 Food Rd., P.O. Box 246, Hsinchu, 300, Taiwan. http://ift.confex.com/ift/2002/techprogram/paper_13663.htm*



Thank you very much and God bless !!!