



FRYING AS A SCIENCE

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“Frying is an art.”

J. Grob (1991)



*“Everybody believed that
frying had its beginnings in
the 1950’s.”*

Dr. Christian Gertz (Lipidforum, 1994)



GROWTH OF FROZEN POTATO INDUSTRY

UNITED STATES FIGURES

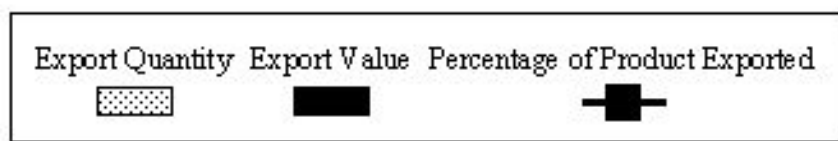
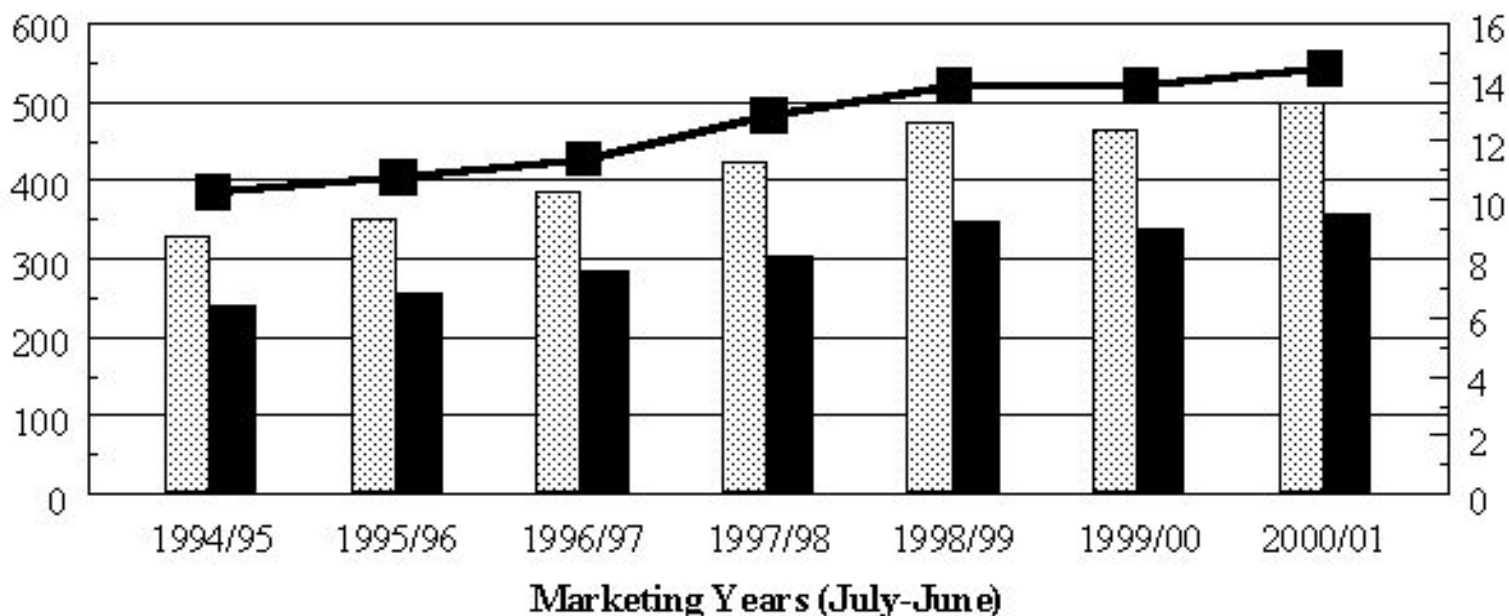
YEAR	POUNDS OF POTATOES
1947	3.5 Million
1972	2.7 Billion
1988	5.2 Billion
1994	7.9 Billion
1997	8.4 Billion



U.S. Exports of Frozen Potato Fries Continue To Rise

1,000 MT and \$ Million

% of Production Exported



Source: U.S. Census Bureau, USDA/NASS, and American Frozen Food Institute

FROZEN POTATO PRODUCTS



SNACK FOOD SALES

(United States)

YEAR	SALES \$ (Billions)	LB VOL (Billions)
1992	13.80	5.18
1994	15.05	5.69
1996	15.41	5.61
1997	16.84	5.77
1998	18.17	5.90
1999	19.38	6.17

Snack Food Association 1999

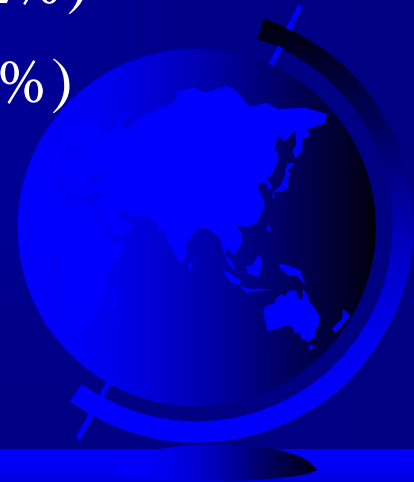


SNACK FOOD SALES BY CATEGORY

(United States in 1999)

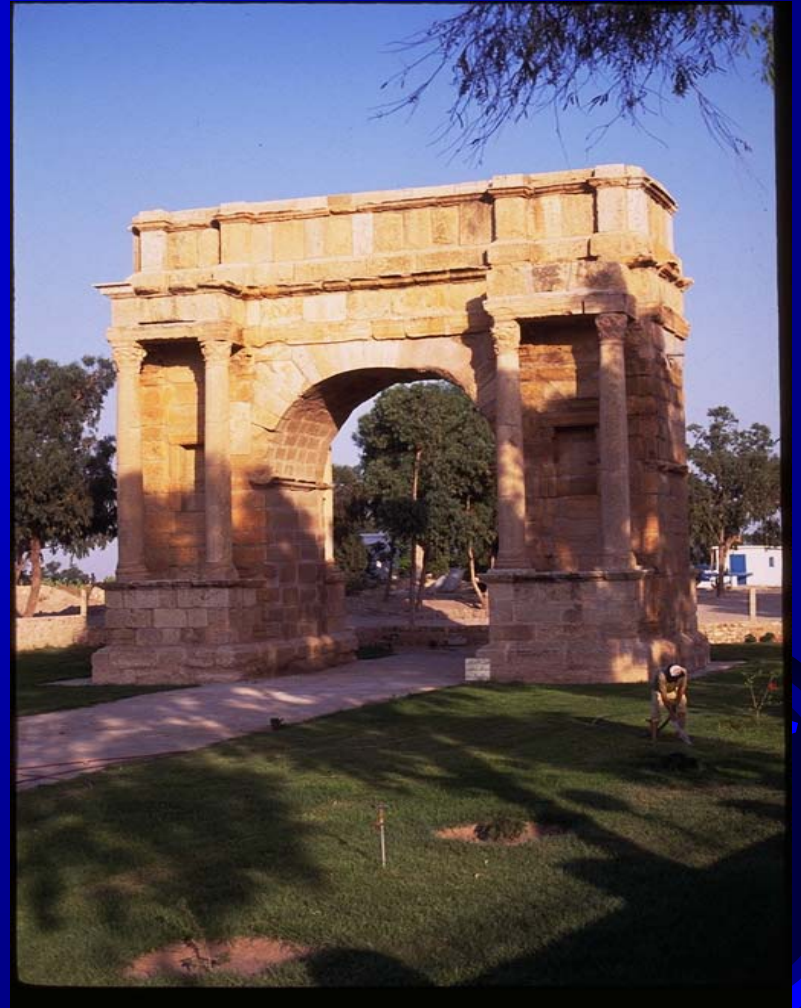
PRODUCT	SALES \$ (Millions)	LB VOL (Billions)
Potato Chips	4,688.1 (2.2%)	1,538.5 (1.4%)
Tortilla Chips	3,748.3 (5%)	1.431.7 (5.7%)
Corn Snacks	847.5 (13.8%)	272.4 (13.6%)
Snack Nuts	1,693.8 (13.7%)	483.6 (11.2%)
Pork Rinds	420.2 (18.4%)	66.5 (18.7%)

Snack Food Association 1999





FRYING IS ANCIENT

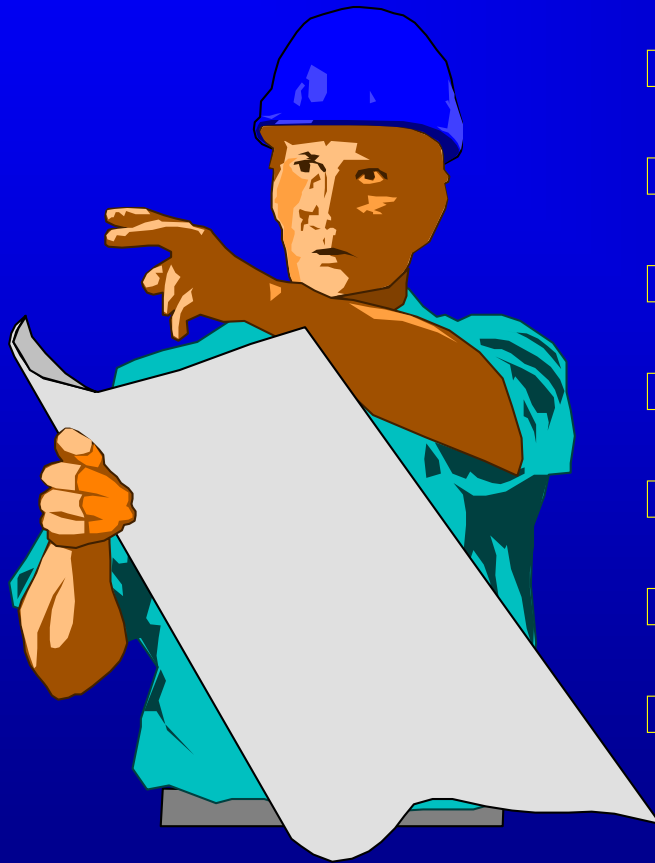


FRYING TIMELINE

YEAR	EVENT
3000 BC	Chinese fry meat prior to roasting
1600 – 1700	Fried potato created
1853	Potato chip invented
1897	Hydrogenation created
1953	Simplot creates par-fried potatoes
1973	1 st DGF Symposium; Oil regs
1979	2 nd DGF Symposium; Polars
1987	Surfactant Theory
2000	3 rd DGF Symposium; Sensory parameters
2004	4 th DGF Symposium ?????



GROWTH OF INDUSTRIAL & FOODSERVICE FRYING



- ❑ Equipment
- ❑ New technologies
- ❑ Packaging
- ❑ Oil Refining
- ❑ Distribution
- ❑ Production efficiencies
- ❑ Understanding the science



DGF RECOMMENDATIONS

- Encourage development of new methods that are faster and more environmentally friendly
- Encourage and support basic research in understanding frying dynamics
- Oil filtration is a basic tool to assure frying oil quality
- Used, but not abused, fats and oils may be topped up

(2000), Eur. J. Lipid Technol., 102:8-9, 594



DGF RECOMMENDATIONS

- ❑ Sensory parameters of food is prime quality index
- ❑ Confirm abuse of fats and oils using TPM and Polymeric Triglycerides
- ❑ Use rapid tests to monitor oil quality
- ❑ No health concerns with consumption of fats and oils that have not been abused



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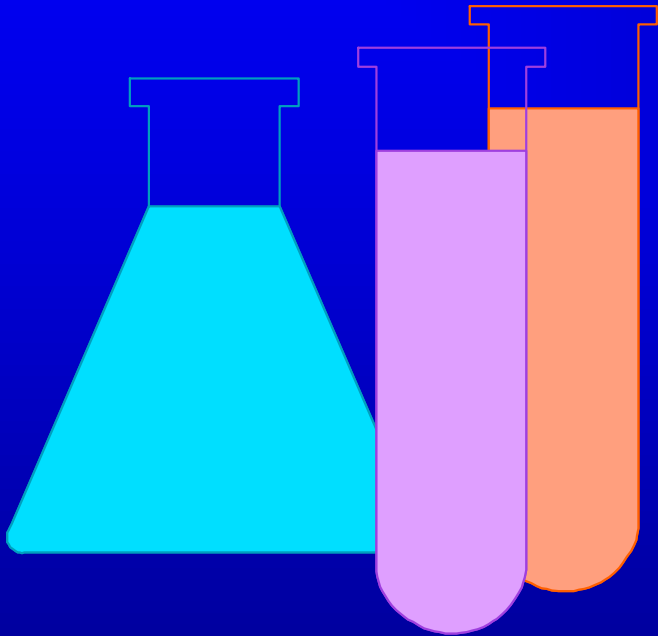
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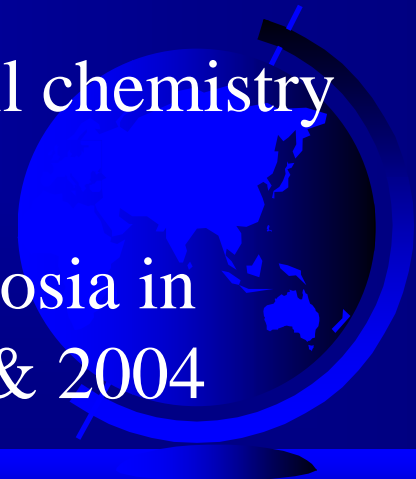
• www.wiley-vch.de



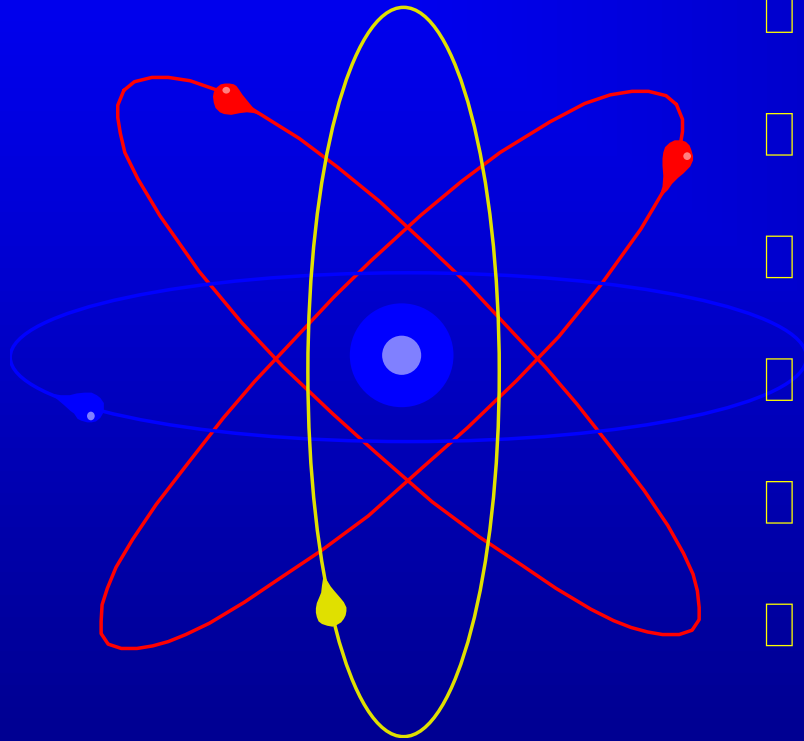
FRYING AS A SCIENCE



- Frying research has been in progress for almost 90 years
- Early work was on oil chemistry (Academia)
- Industrial research on the process
- Relationships of oil chemistry to process ignored
- DGF Frying Symposia in 1973, 1979, 2000 & 2004



SYSTEMS APPROACH



- M. Blumenthal (Libra)
- R.P. Singh (UC Davis)
- S. Saguay (Israel)
- B. Farkas (NC State)
- Escher (Switzerland)
- Plus many more



SURFACTANT THEORY

- Frying is a dehydration process. When food is fried, water and any materials in that water are pumped out of the food into the surrounding oil.
- The heat transfer medium, oil, is non-aqueous and the food being prepared is almost all water. Oil and water are immiscible.
- For frying to occur, heat must be transferred from the non-aqueous medium, oil, to the mostly aqueous medium, the food
- Any changes in heat transfer or cooking ability of the food, must result from degradation products or chemicals formed as a result of breakdown of the oil.



SURFACTANT THEORY

- The food materials leaching into the oil itself and oxygen absorption at the air-oil interface contribute to changing the makeup of the oil from a pure triglyceride into a mixture of literally hundreds of compounds.
- Those materials that affect heat transfer at the oil-food interface must act to reduce the initially high surface tension between two immiscible substances.
- As the oil degrades, more surfactant materials are formed, causing increased contact between food and oil

M.M. Blumenthal (1985)



NEW ANALYTICAL TOOLS

- Instrumental methods of analysis
- Near Infrared (NIR)
 - Snacks
 - Fries
 - Oil
- Electronic nose (Cyrano Sciences)



RAPID METHODS

- Test strips - 3M, Advantech
- Quick tests - Merck, Libra
- Instruments - FOS
- New Tests
 - PCT 120 (3M)
 - FRI-CHECK (Good-Fry)



NEW INGREDIENTS

- Antimicrobials
- Heat stable flavors
- “All Natural”
- Natural antioxidants
 - Good-Fry
 - Blend of sesame, rice bran oil



FRYING OILS

- ❑ Suppliers manufacture a range of oil products
- ❑ Customer service increasingly important
- ❑ Product/process development
- ❑ Hydrogenation?????



QUALITY CONTROL IN FRYING

- ❑ Design, construction & maintenance of equipment
- ❑ Proper operation of equipment
- ❑ Properly clean equipment
- ❑ Minimize exposure to UV
- ❑ Keep salt & metals away from oil
- ❑ Filter regularly

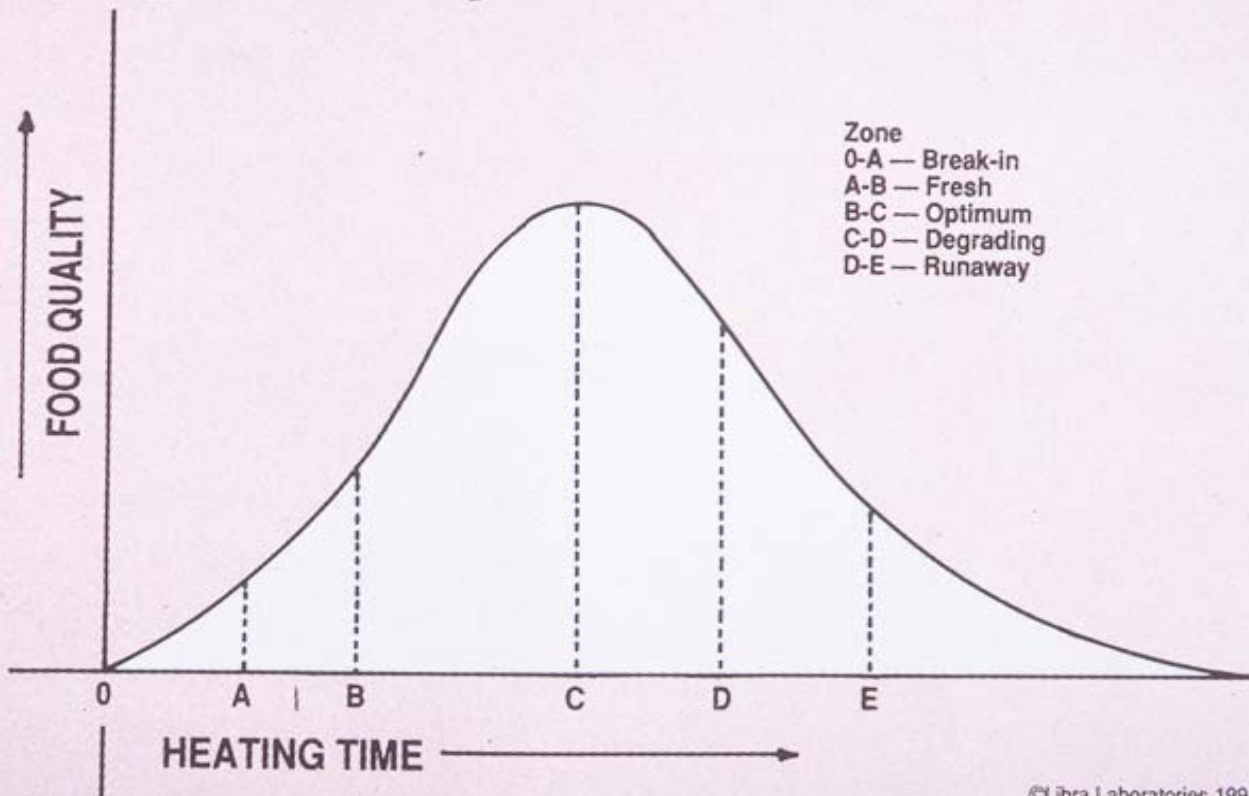
Robertson (1967), Food Technol.21:1, 34-38



FRYING OIL QUALITY CURVE

Figure 1

Frying Oil Quality Curve



GUIDELINES FOR RESEARCH?

- *“Encourage and support basic research focused on understanding the dynamics of deep-fat frying and the frying process. Research should be cross-discipline encompassing oil chemistry, food engineering, sensory science, food chemistry and nutritional sciences.”*



GUIDELINES FOR RESEARCH?

- ❑ Frying Studies – Baseline data
- ❑ What tests to do? What do they mean?
- ❑ Oil safety
- ❑ Engineering aspects
- ❑ Should we as a group take this route?



FRYING STUDIES - DEVELOPING BASELINE DATA

- Polar Materials
- Polymers
- Soaps
- Iodine Value
- Metals
- Anisidine Value
- Free Fatty Acids
- Peroxide Value
- Lovibond Color
- Fatty Acid Profile
- Mono, Di & Triglycerides
- Oil/Food Interactions



FRYING STUDIES - DEVELOPING BASELINE DATA

HEATED OIL - PHYSICAL MEASUREMENTS/OBSERVATIONS

- Suspended Solids
- Smoke & Flash Points
- Lovibond Color (R, Y, & B)
- Foam Height
- Evidence of Polymer Formation
- Heat recovery Curves



FRYING STUDIES - DEVELOPING BASELINE DATA

SENSORY ANALYSIS OF FOODS

- Flavor
- Odor
- Appearance
- Utilize Different Sensory Methods



FRYING STUDIES - DEVELOPING BASELINE DATA

EVALUATE THE PROCESS

- Oil Usage
- Oil Life
- Worker Safety
- Food Safety
- Oil Chemistry
- Food Quality
- Regulatory Issues
- Environmental Concerns
- Fryer Condition
- Food Quality
- Ease of Use



OIL TESTS

- Define not just methods but value of tests
 - Example, anisidine value – Popular in Europe, but many in US do not realize how important
- What should be done?
- Emphasize how tests relate to industrial/foodservice frying and refining



DESIGN OF FRYING STUDIES

RECOMMENDED SAMPLING SCHEDULE

- Fresh Oil
- Hot Oil Before Frying
- 1/2 Hour After Frying
- 1,2, 4 & 8 Hours After Frying
- End of Shift
- End of Day's Operation
- Endpoint Oil



ENGINEERING STUDIES

- Guide to systems approach
- Monitoring food and oil quality and defining interrelationships
- Industrial applications and funding



SUMMARY

- ❑ Frying is an ancient process
- ❑ Has grown exponentially in last 50 years
- ❑ Last 15 have seen researchers look at frying as a system – oil, food, fryers and other inputs
- ❑ Requires multidisciplinary approach
- ❑ Should this group seek to set guidelines?

