อาหารยุคใหม่: อร่อยดีและมีประโยชน์

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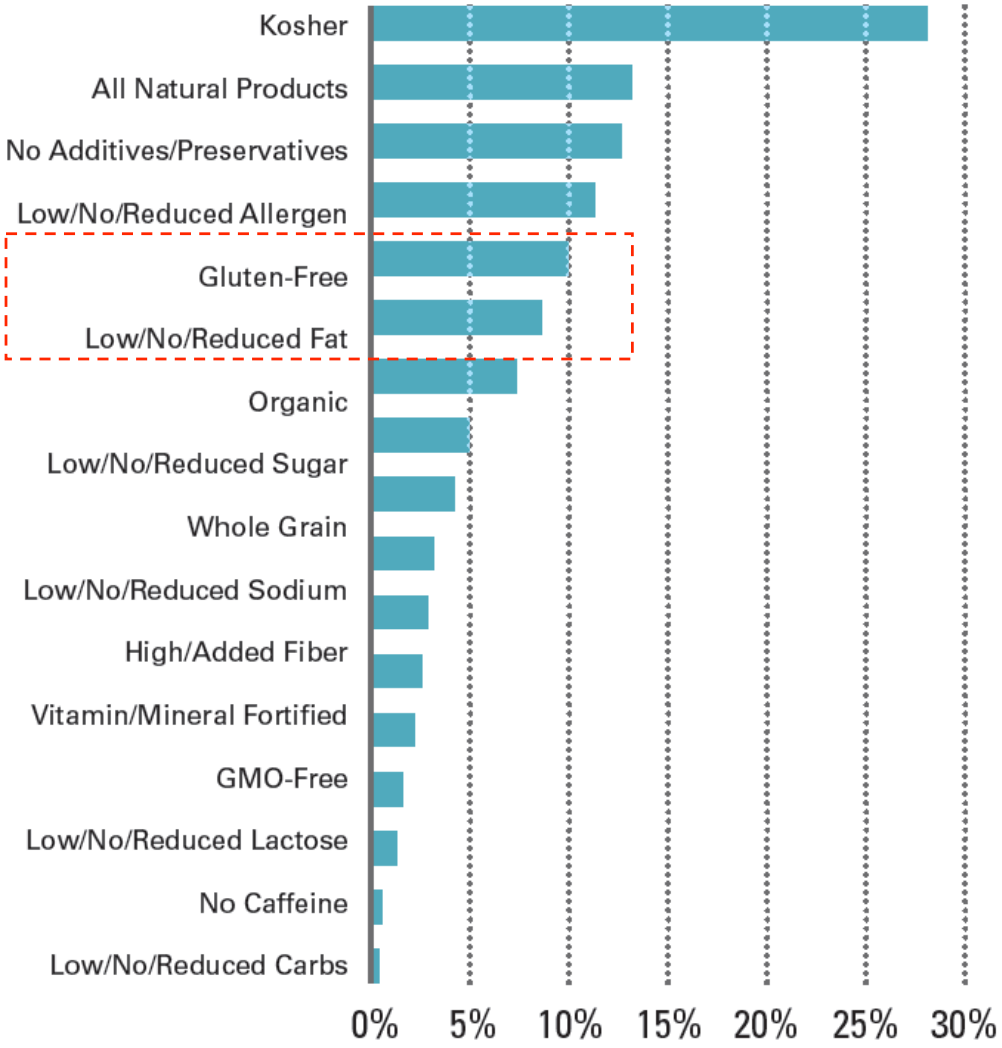
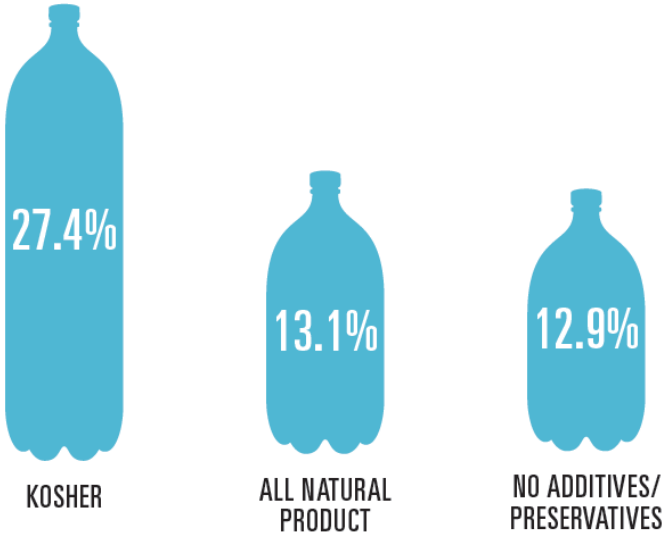
Present at NAC 2013 : 1st April 2013

Health-Related Food Claims



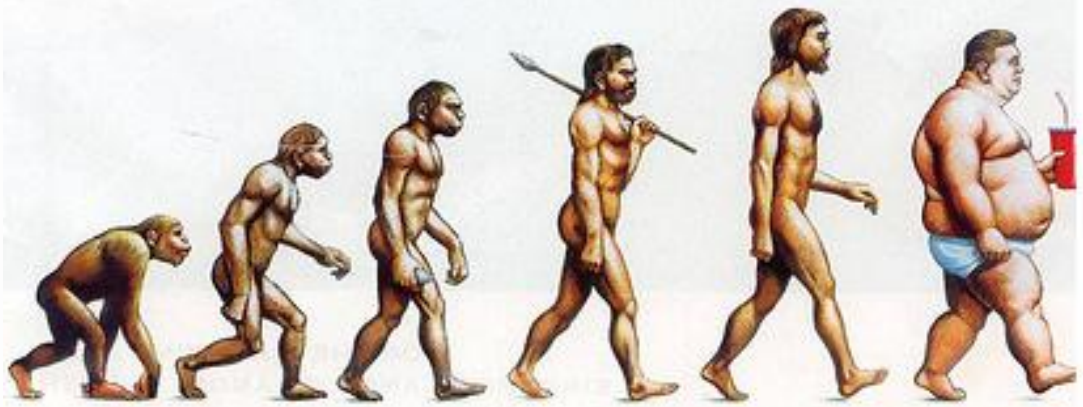
Source: Mintel GNPD, February 2012

- **Products survey from 20,000 new products introduced in 2011**



Source: Mintel GNPD, February 2012

The shape of things to come



The world is too fat. Too bad

WHEN the world was a simpler place, the rich were fat, the poor were thin, and right-thinking people worried about how to feed the hungry. Now, in much of the world, the rich are thin, the poor are fat, and right-thinking people are worrying about obesity.

The Economist, 11th December 2003

Global Obesity Trends

Source: World Health Organization (WHO)

- In 2005 WHO survey, at least 400 million people worldwide were obese
- Prediction for 2015, more than 700 million people will be obese!!

Deep Fried Foods

- Frying is the process of cooking and drying through contact with hot oil which involves simultaneous heat and mass transfer.
- Battering and breading are flour-water mixture and traditionally coated on foods e.g.
meats and vegetables to enhance appearance, texture, flavour, colour and yield.
- High fat content in fried product leads to health concern e.g. obesity, heart disease.
- Many types of hydrocolloids e.g. cellulose ethers, xanthan and pectin successfully reduce oil content in fried food.
- Modified starch also has a potential as a component in batter ingredient.

Mechanisms of Deep Frying

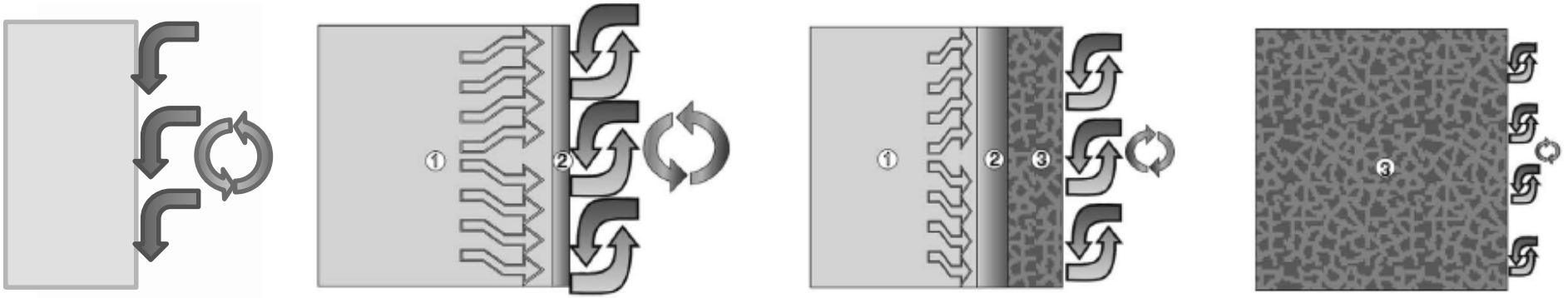
Period 1: initial heating
No evaporation
10 s
Heat transfer: convection

Period 2: surface boiling
Water vaporization
20 -60 s
Heat transfer: forced convection

Period 3: falling rate
Moisture lost
60 - 400 s
Heat transfer: forced convection
Gelatinization/cooking

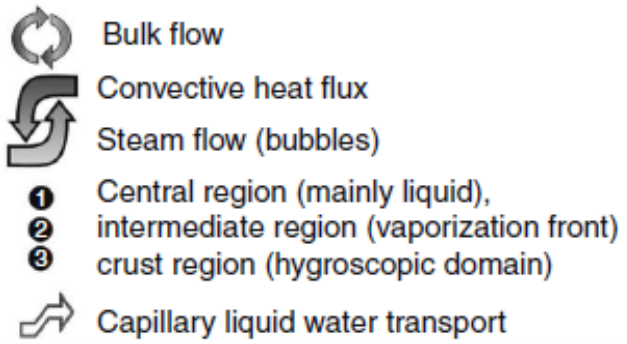
Period 4: bubble end point
cessation of moisture loss

reduction in heat transfer
Oil absorption



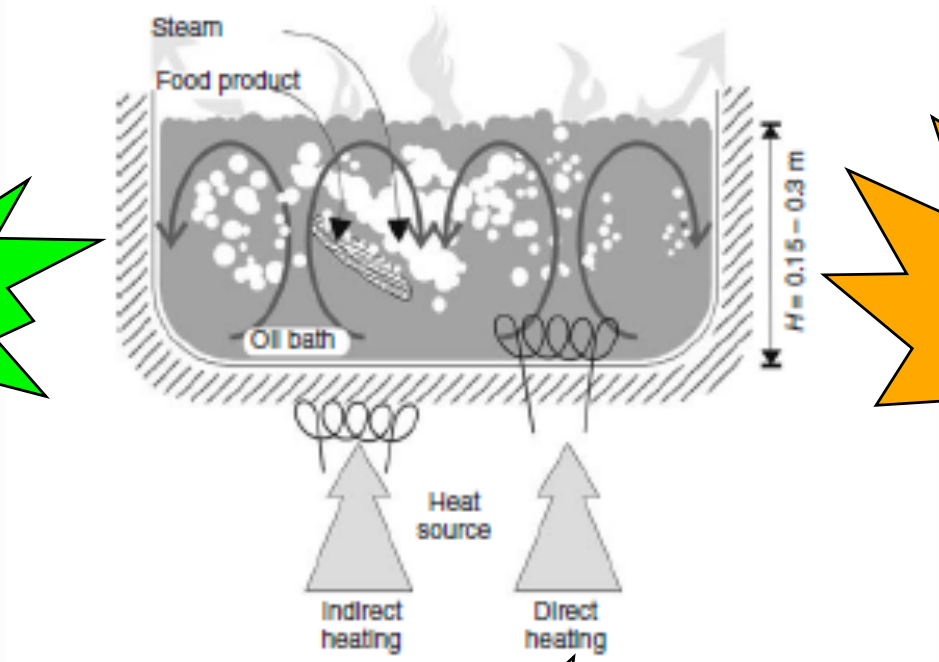
Advances in Deep-Fat Frying of Foods, *edited by Serpil Sahin and Servet Gülüm Sumnu* (2009)

Heat and vapor flow



Crust formation

Fat transfer



Mass (moisture) transfer

Heat transfer

Mechanisms of Oil Absorption

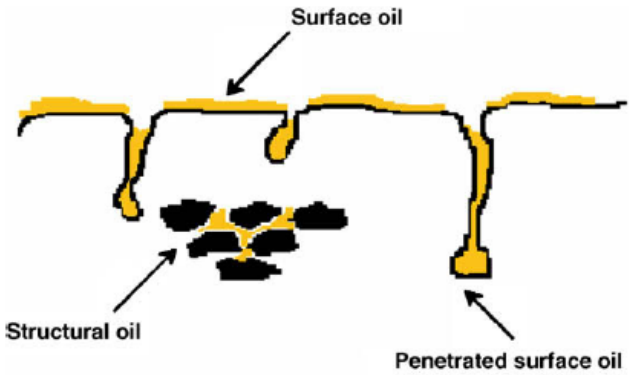


Figure 11.2: Diagram showing the three locations of oil in the crust of a fried potato piece according to Bouchon et al. (2003) (used by permission of the Journal of Food Science, Institute of Food Technologists).

Proposed Mechanism:

- Water replacement
- Cooling-phase effect
- Surfactant theory of frying

Mechanism I: Water Replacement

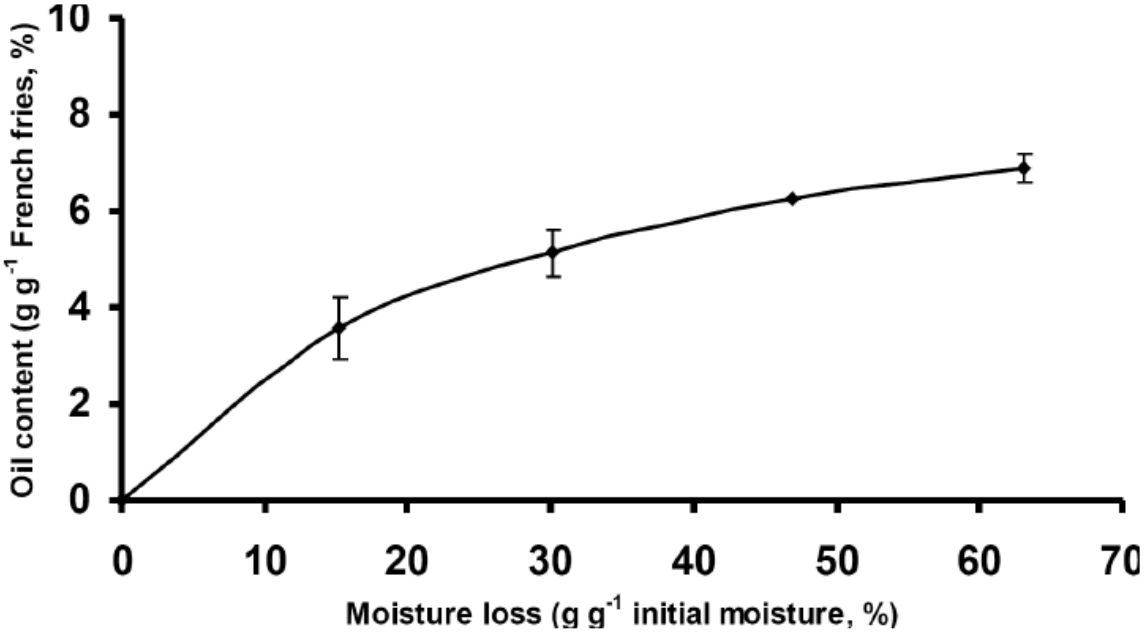


Fig. 5. Oil content vs. moisture loss in French fries during frying at 155°C (Ziaiifar *et al.*, paper in preparation).

- Escape of moisture and oil uptake ~ square root of frying time
- Water escape → void/pore → oil entering
- Most important for battered and starchy products (large voids/ pores)

Mechanism II: Cooling-Phase Effect

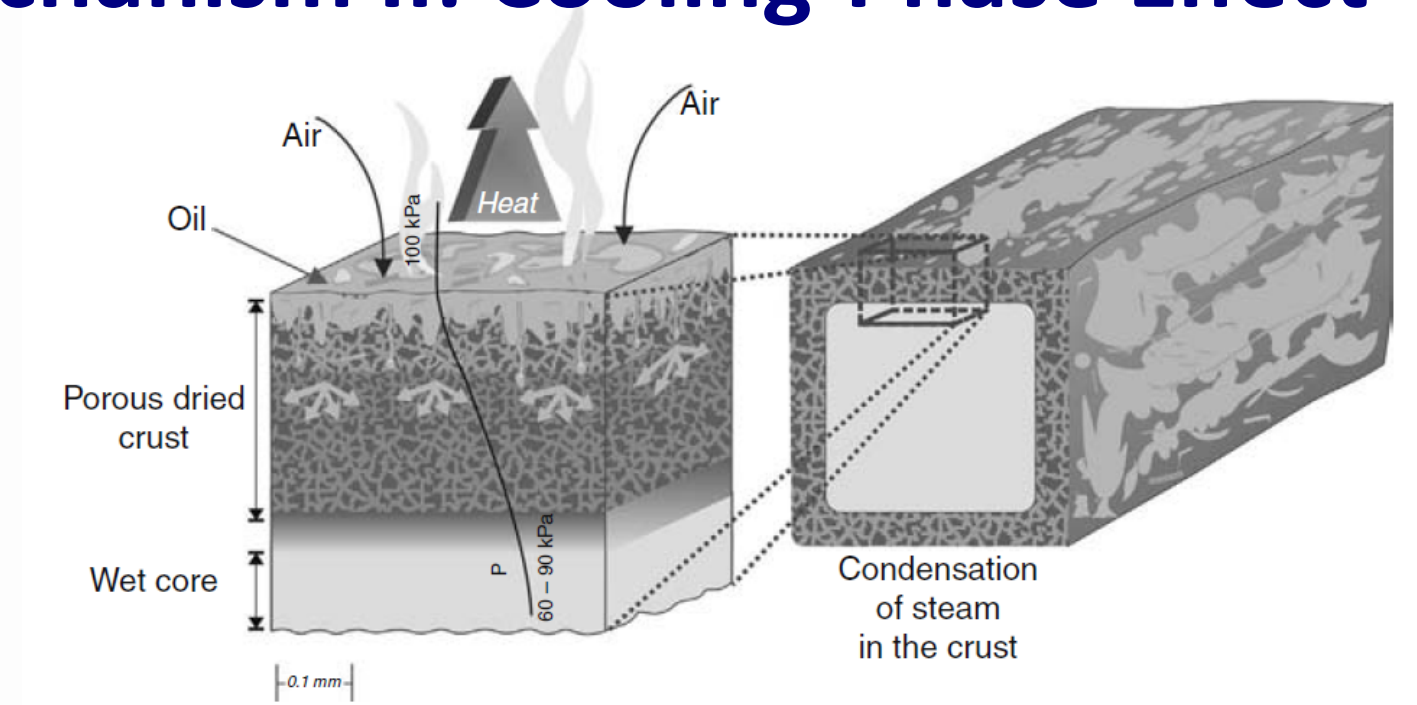


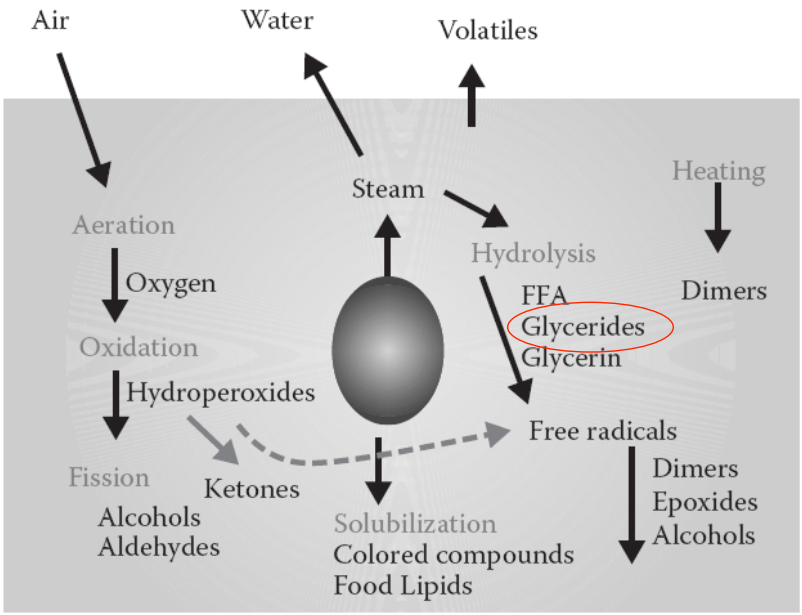
FIGURE 2.17 Physical interpretation of oil uptake during cooling.
Advances in Deep-Fat Frying of Foods, *edited by Serpil Sahin and Servet Gülüm Sumnu* (2009)

porous crust ~ capillaries

Frying stage: P(steam) > P(surface) = 100 kPa → *no oil enters the pores*

Cooling stage: P (wet core) = 60 – 90 kPa + water condensation and
P(surface) = 100 kPa → capillary force + vacuum effect
→ *oil enters the pores*

Mechanism III: Surfactant Theory of Frying



Oil degradation kinetics.

Mainly observed in the process with long frying time

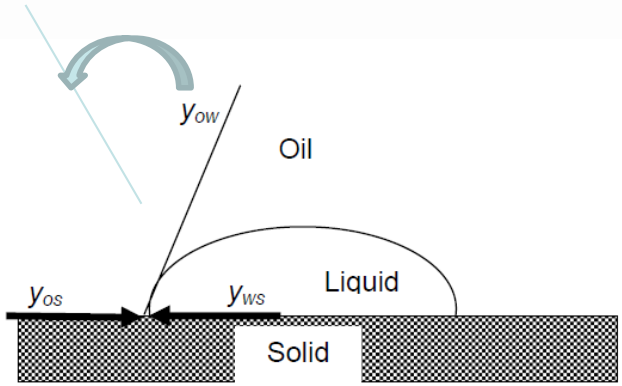


Figure 2.3 Interfacial tension between oil, water and food solid. (Source: Adamson, 1990. Physical Chemistry of Surfaces).

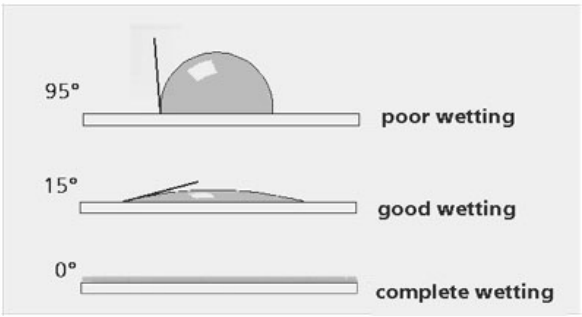
Surface active agent: mono/diglycerides

Surface tension between oil and crust ⇩

→ wetting of oil on food surface

→ contact of oil and food surface ⇧

→ excessive oil absorption



Factors Affecting Oil Uptake

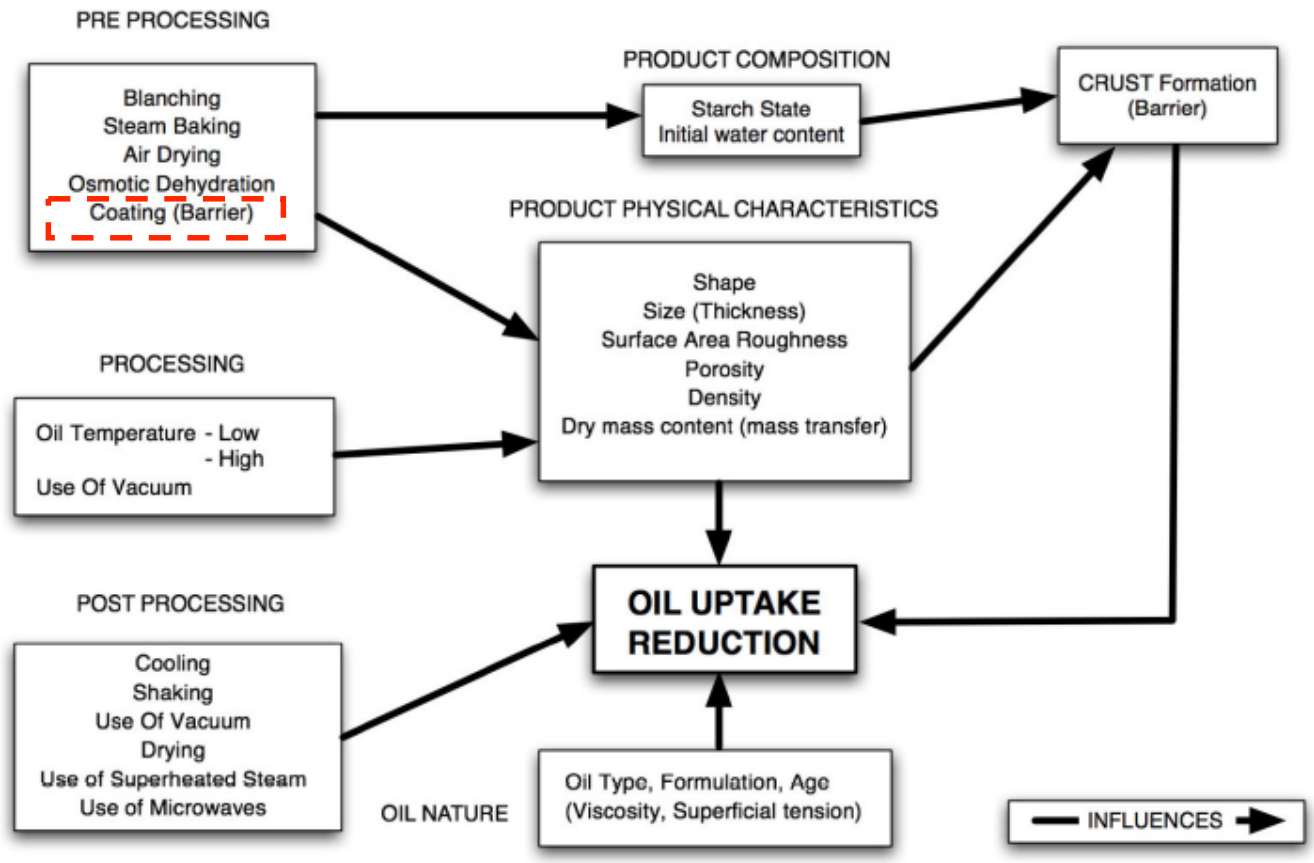
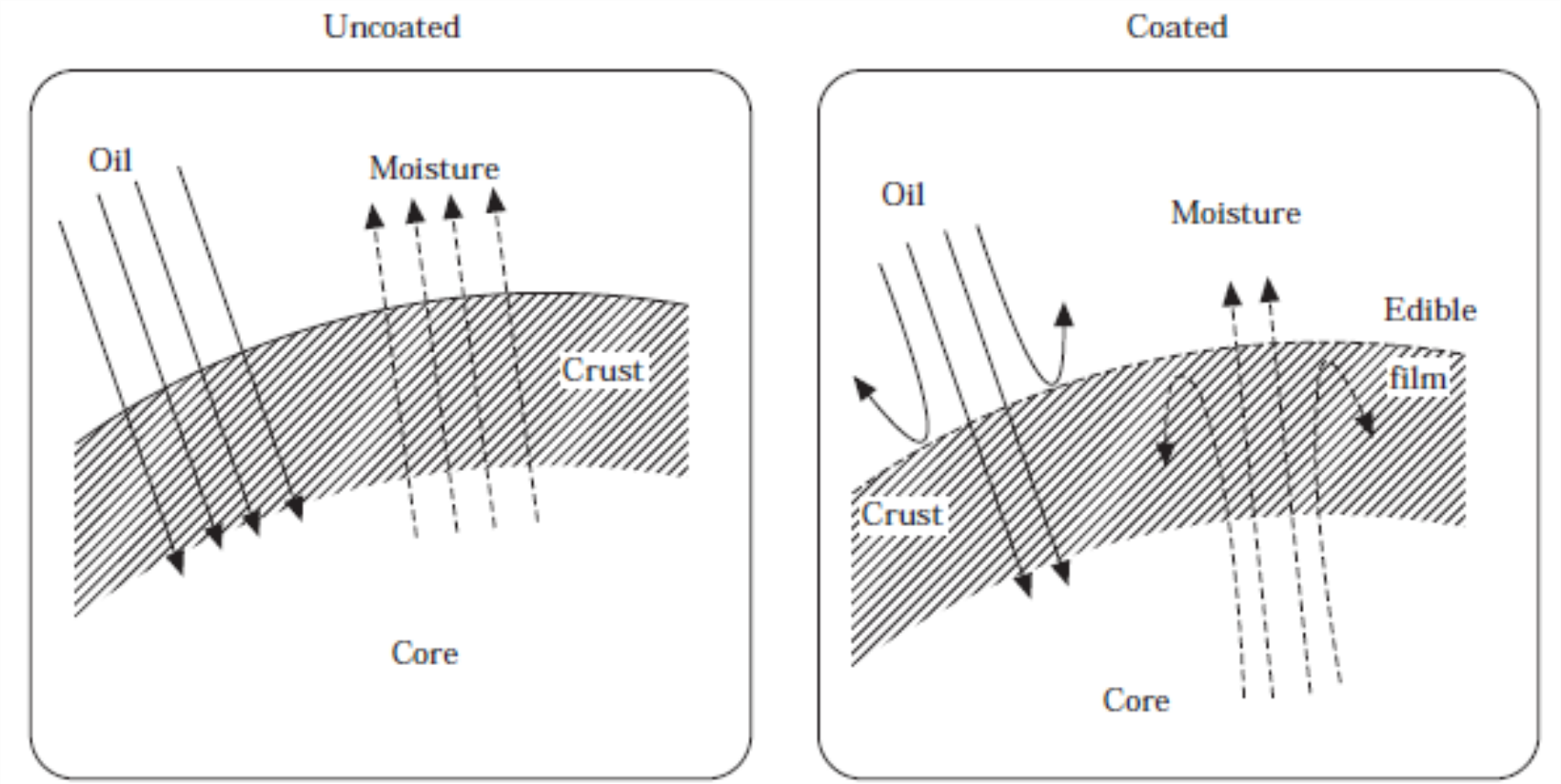


Figure 8: Important factors involved in the frying operation affecting oil uptake.

Ziaiifar et al. (2008) Review of mechanisms, conditions and factors involved in the oil uptake phenomenon during the deep-fat frying process, Int J Food Sci & Tech 43, 1410-1423.

Reduction of Oil Uptake Using Hydrocolloids



Conceptual diagram illustrating the effect of edible films on moisture and fat transfer during deep-fat frying

Mallikarjunan *et al*., 1997. "Edible Coatings for Deep-fat Frying of Starchy Products" *Lebensm-Wiss u-Technol,* 30, 709-714.

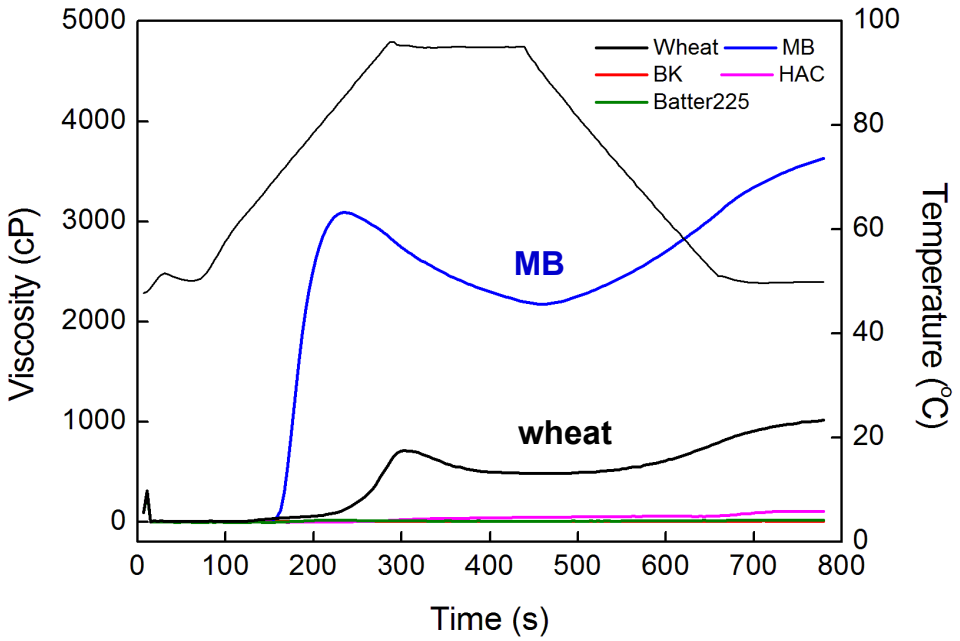
Scope of Research

- To study fundamental properties, including physical and rheological properties of the selected modified starches that can be used as batter ingredients for fried chicken products
- To investigate characterstics and oil contents of fried chicken products that are prepared using various batter formulations.

Materials

❑ Modified starches

- ➢ Crosslinked tapioca starch (Kreation MB)
- ➢ Crosslinked tapioca starch (Kreation BK)
- ➢ Acetated high amylose corn starch (HAC)
- ➢ Oxidised tapioca starch (Batter225)



Starch	WAI	WSI (%)
Wheat	2.25 ± 0.02	7.24 ± 0.17
Kreation MB	1.82 ± 0.05	0.22 ± 0.05
Kreation BK	1.84 ± 0.02	0.29 ± 0.18
HAC	2.27 ± 0.06	0.73 ± 0.05
Batter225	1.68 ± 0.04	1.05 ± 0.11

WAI : water absorption index

WSI : water solubility index

Materials, Cont

❑ Batter formulation and preparation

Batter formulations

Ingredients	Control	Modified starch
Wheat flour (%)	80	60
Modified starch (%)	-	20
Corn flour (%)	10	10
Leavening (%)	2	2
Spices (%)	3	3
Milk powder (%)	2	2
Sugar (%)	2	2
Salt (%)	1	1
Powder : water ratio	1: 1.3	

Batter preparation

All dry mixed ingredients

⇩

Add cold water (10-15°C)

⇩

Stir for 20 min

⇩

Refrigerate batter at 3°C for 1 hr

Experimental

❑ Measurement of water retention capacity (WRC)

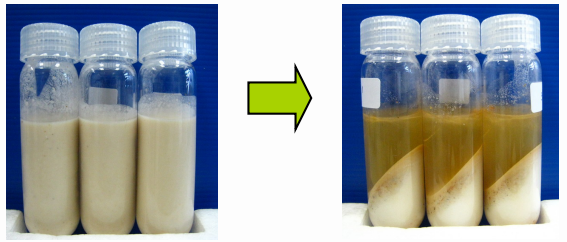
Batter (30 g) in 50-ml centrifuge tube

↓

Centrifuge at 2500 rpm for 10 min at 15°C

↓

Remove and weigh supernatant



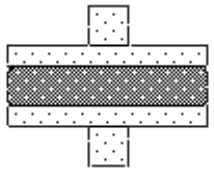
$$\text{WRC (\%)} = \left[1 - \frac{\text{weight of supernatant (g)}}{\text{weight of batter (g)}}\right] \times 100$$

❑ Rheological properties

- Steady shear tests between 0.01-100 1/s at 15°C using a parallel plate of 55 mm diameter
- Flow curves between shear rates of 1-10 1/s fitted with Herschel-Bulkley model
to obtain the consistency (*K*) and flow behaviour (*n*) indices

Herschel-Bulkley model →

$$\sigma = \sigma_0 + K\dot{\gamma}^n$$



Parallel plate

Experimental, Cont

❑ Measurements of batter pick-up and cooked yield

- ➢ Batter pick-up relates to how much batter adheres to food substrate before frying.
- ➢ Cooked yield relates to the product yield after frying.

Skinless-boneless chicken breasts
(30x50x10 mm, ~15 g)
↓
Predust
↓
Dip in batter refrigerated at 3°C
↓
Drain for 10s
↓
Breading
↓
Shake
↓ → Weigh without frying
Fry at 180°C, 5 min

$$\text{Pick up (\%)} = \frac{(\text{battered chicken} - \text{chicken}) \times 100}{\text{battered chicken}}$$

$$\text{Cooked yield (\%)} = \frac{\text{cooked breaded chicken} \times 100}{\text{raw chicken}}$$

Experimental, Cont

- Determination of oil content using DSC technique
  - A rapid technique to monitor phase change of lipid crystallisation in fried products

Crust of fried chicken

⇩

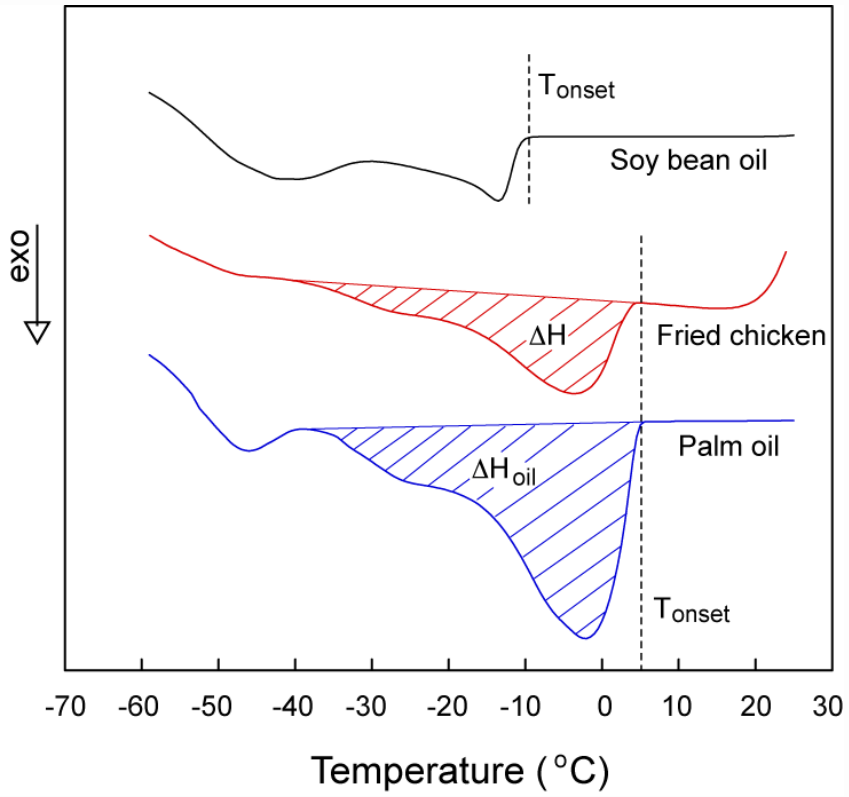
Cut into small pieces

⇩

Load into aluminium crucibles (~40mg)

⇩

Measure the enthalpy of oil crystallisation (ΔH) using DSC (25 - (-60°C))



$$\text{Oil content (\%)} = \frac{\Delta H_{sample}}{\Delta H_{oil}} \times 100$$

Frying Procedure

Skinless-boneless chicken breast
(30x50x10 mm, ~15 g)

↓

Predust

↓

Dip in batter refrigerated at 3°C

↓

Drain for about 10 sec

↓

Breading

↓

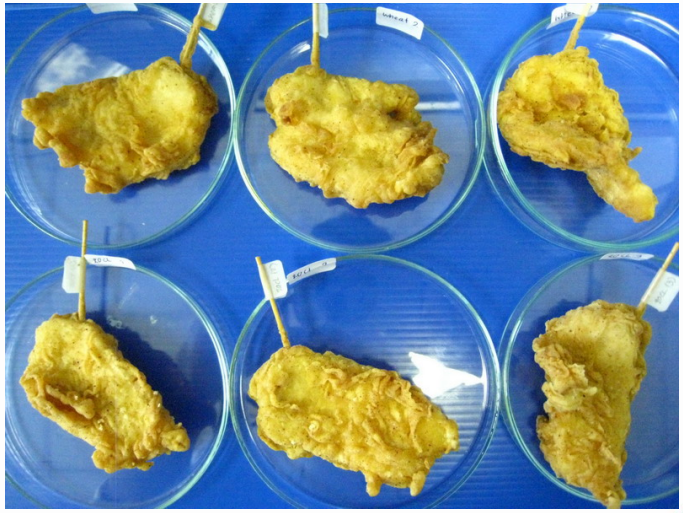
Shake to provide crusty texture

↓

Fry with palm oil at 180°C for 5 min

↓

Cool down for 5 min before testing

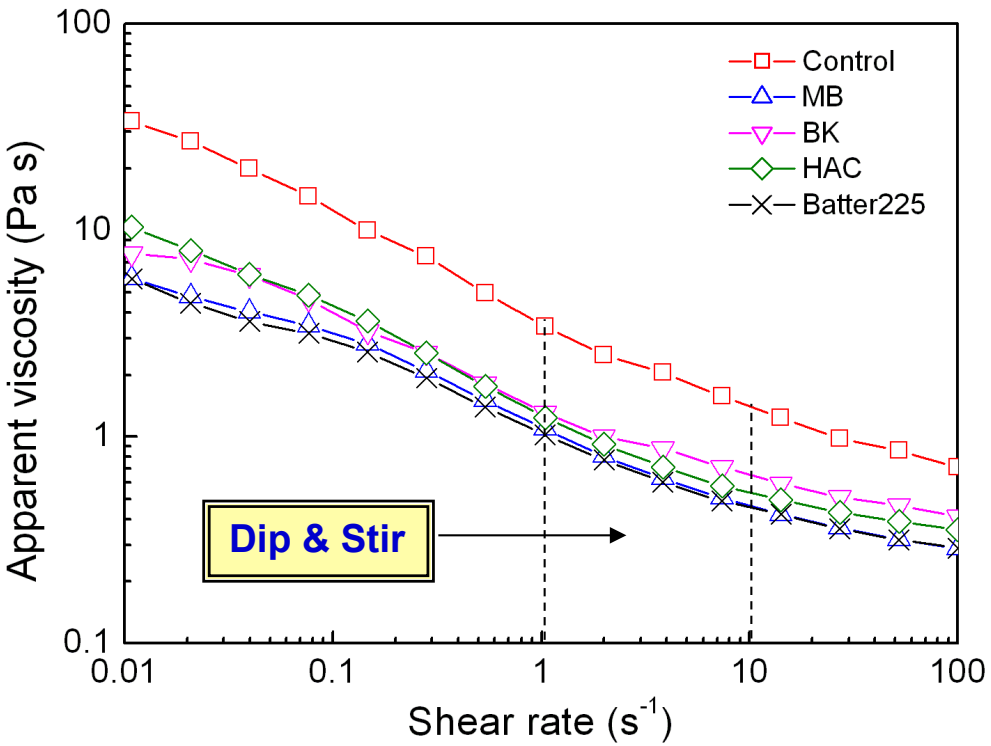


Water Retention Capacity

Batter formulation	WRC (%)
Control	77.78 ± 0.00[a]
20% Kreation MB	72.15 ± 0.18[d]
20% Kreation BK	71.21 ± 0.03[e]
20% HAC	75.50 ± 0.26[b]
20% Batter225	72.94 ± 0.20[c]

- The substitution of 20% modified starch into the batter formulation decreased the WRC of the batters.
- The batter containing Kreation BK had the lowest WRC.

Rheological Properties

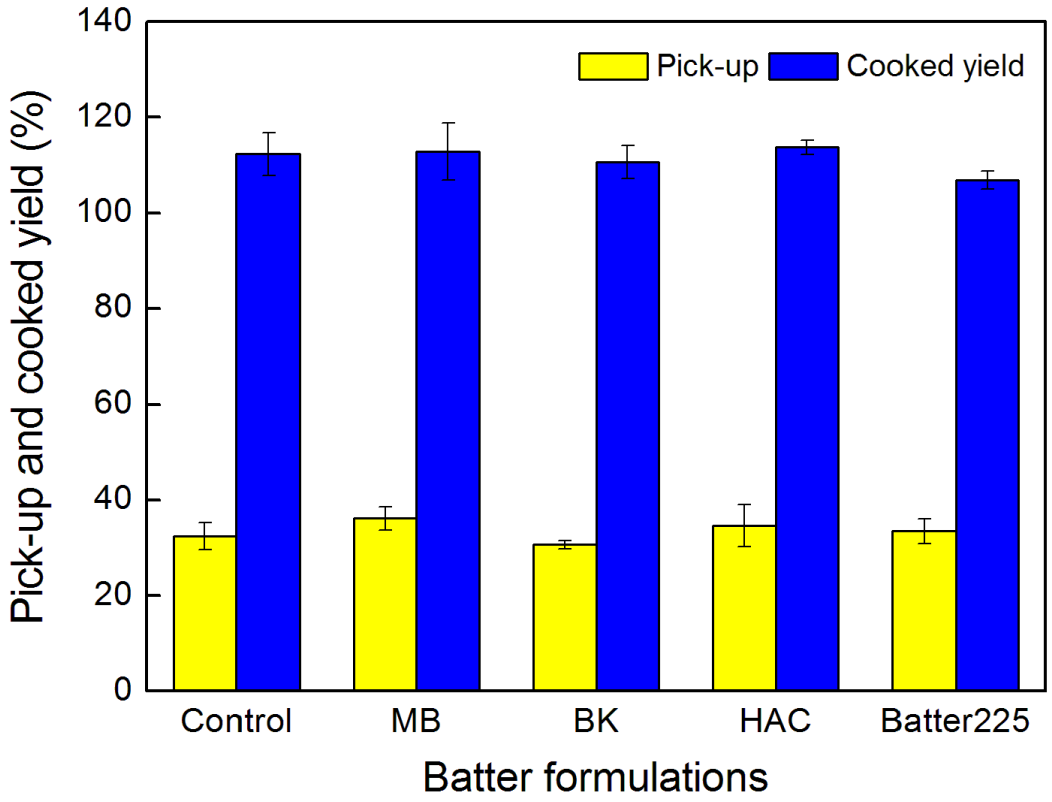


HB model ⇨ $\sigma = \sigma_0 + K\dot{\gamma}^n$

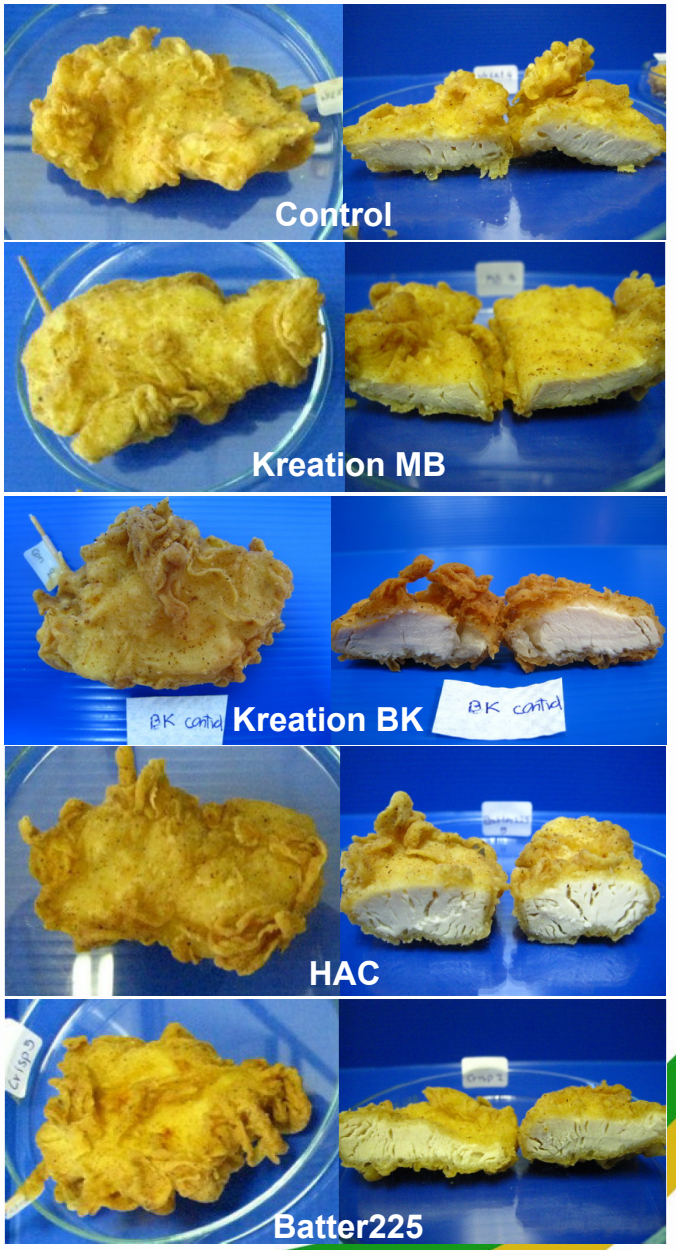
Batter formulation	*K* (Pas^n)	*n*
Control	3.54±0.03[a]	0.59±0.00[c]
20% Kreation MB	1.05±0.03[d]	0.64±0.02[b]
20% Kreation BK	1.31±0.02[b]	0.69±0.00[a]
20% HAC	1.21±0.00[c]	0.63±0.01[b]
20% Batter225	1.00±0.03[d]	0.64±0.00[b]

- All batter formulations showed shear thinning behaviour.
- The substitution of 20% modified starch decreased viscosity/consistency of the batters, resulting from the dilution of wheat flour proteins.

Pick-up and Cooked Yield

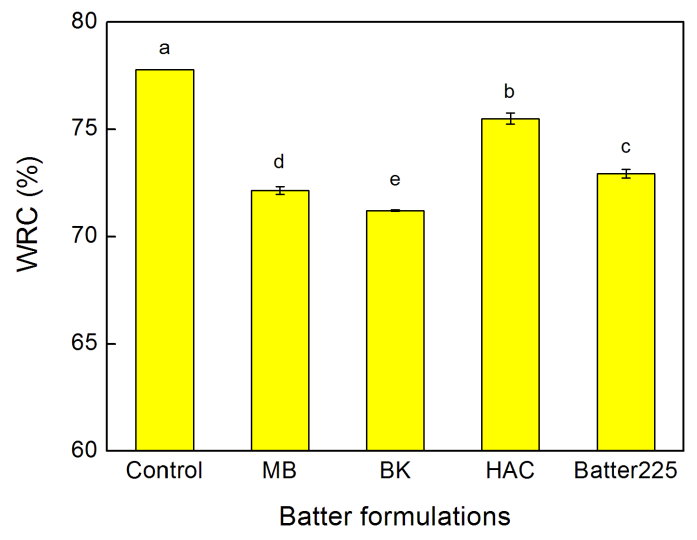


➢ Batter pick-up (31-36%) and cooked yield (107-114%) were not significantly different among the batter formulations.



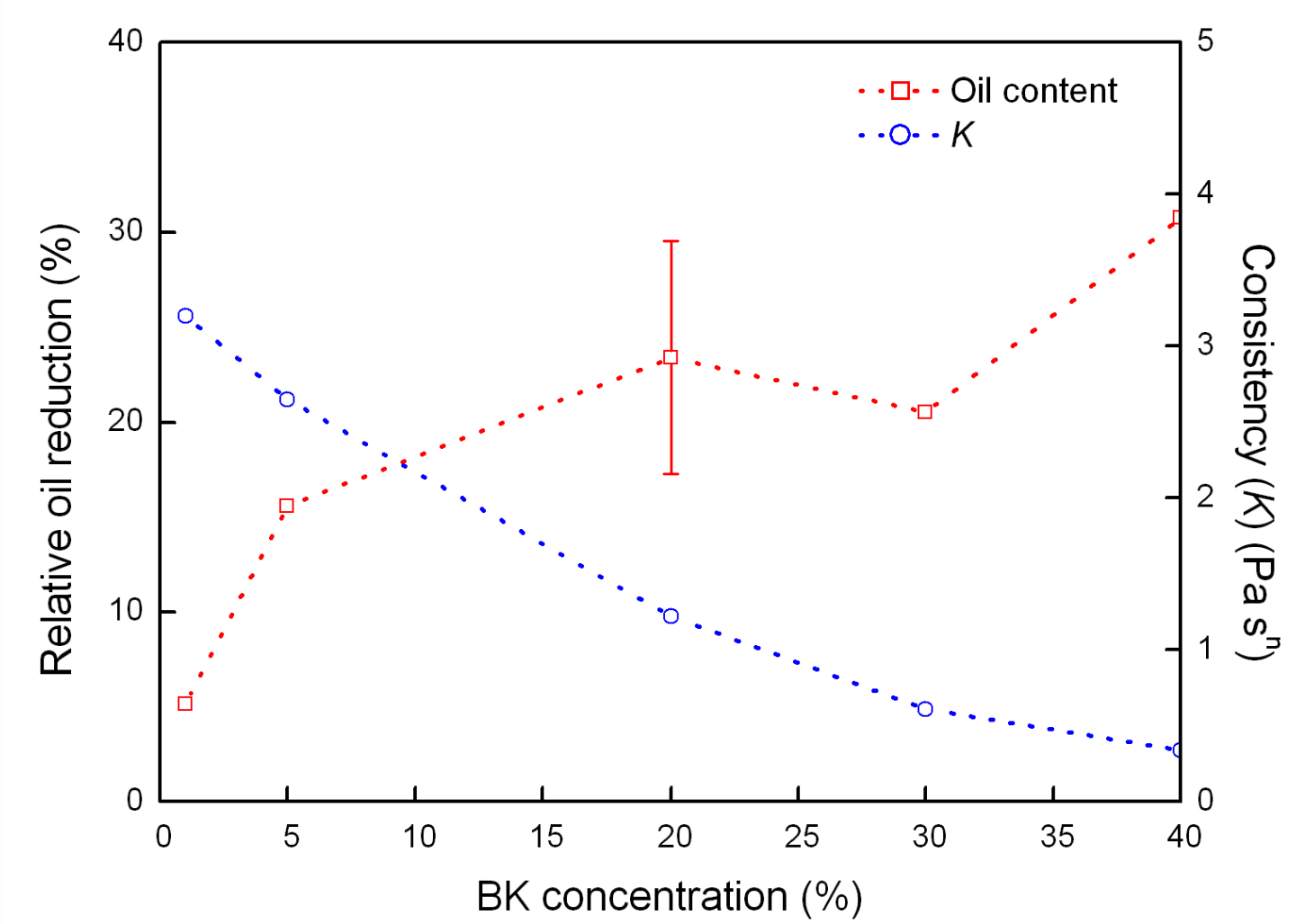
Oil Absorption

Batter formulation	Oil content (%)
Control	43.19±0.83[a]
20% Kreation MB	35.91±0.35[b]
20% Kreation BK	31.86±2.33[c]
20% HAC	33.06±0.58[c]
20% Batter225	32.35±2.08[c]



- The substitution of 20% modified starch into the batter formulation decreased the oil content in crust of fried chicken.
- The batter containing Kreation BK had the highest relative oil reduction (~26%).

Effect of Modified Starch Content



- Kreation BK concentration ↑ Viscosity ↓ relative oil reduction ↑

Summary

- The substitution of 20% modified starches in the batter formulations reduced water retention capacity and viscosity of the batters.
- Batter characteristics e.g. pick-up and cooked yield were not affected by the replacement of 20% modified starches.
- Batters containing 20% modified starches significantly lowered oil absorption in crust of fried chicken with the highest oil reduction of Kreation BK batter.
- The degree of cross-linking which in turn resulted in the limited hydration property could be the leading factor in the reduction of oil content for the modified starch-substituted batters.
- More information can be found in Gamonpilas et al. (2013) *Effects of cross-linked tapioca starches on batter viscosity and oil absorption in deep-fried breaded chicken strips*, J. Food Eng 114, 262-268

Thank you