The Less Oil Uptake Strategies in Deep-Fat Frying

CELAL BAYAR ÜNİVERSİTESİ

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CONGRESS CO-CHAIR

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Frying is the cooking of food in oil or another fat, a technique that originated in ancient Egypt around 2500 BC.

Regarding Frying

Owing to to their unique and delicious flavor and sensory characteristics, FRIED FOOD products remain very popular world-wide…

Fried Product

- ✓ ***Effective Way to Cook***
- ✓ ***Good Taste***
- ✓ ***Good Flavour***
- ✓ ***Rapid Preparation***

Most Consumed Frying Oils

Sunflower Oil
Vegetable Blend Oil
Canola Oil
Palm Oil
Corn Oil
Olive Oil

(*Boskou & Visioli, 2003 ; Tokuşoğlu,2013).*

✓ **Virgin olive oil (VOO) is unique among cooking oils due to its high monounsaturated fatty acid (MFA) level and the presence of health-promoting microconstituents including polyphenols, terpenoids, squalene and tocopherols**

Despite the common belief, frying process is considered to have almost the same or even less effect on nutrient losses compared to other cooking methods

Besides, the nutritive value of food increases owing to the absorption of frying oils (especially olive oils), that are rich in unsaturated fatty acids & vitamin E

(Bogna´ r, 1998; Fillion & Henry, 1998; Andrikopoulos et.al.,1989),

Fats can reach much higher temperatures than water at normal atmospheric pressure. Through frying, one can sear or even carbonize the surface of foods while caramelizing sugars.

Hovewer, slimness trend and acrylamide scare, the market of fried products is still developing…

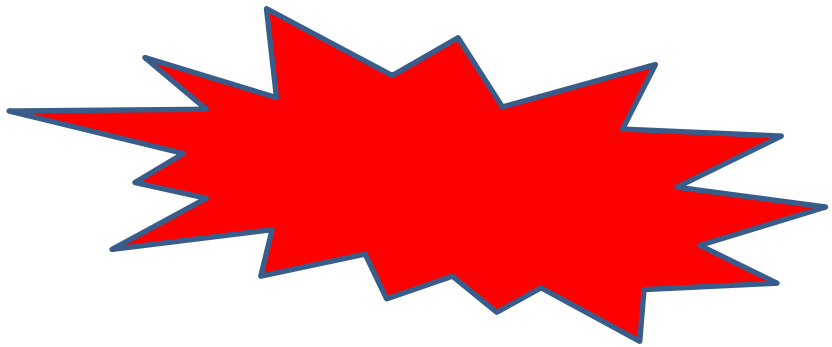
Frying techniques vary in the amount of fat required, the cooking time, the type of cooking vessel required, and the manipulation of the food.

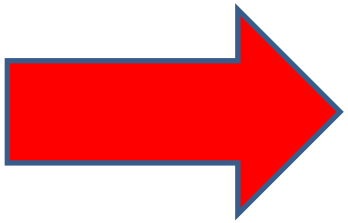
Standard Frying Techniques

- Sautéing
- Stir Frying
- **Pan Frying** — Most Preferred
- Shallow Frying
- **Deep Frying** — Most Preferred

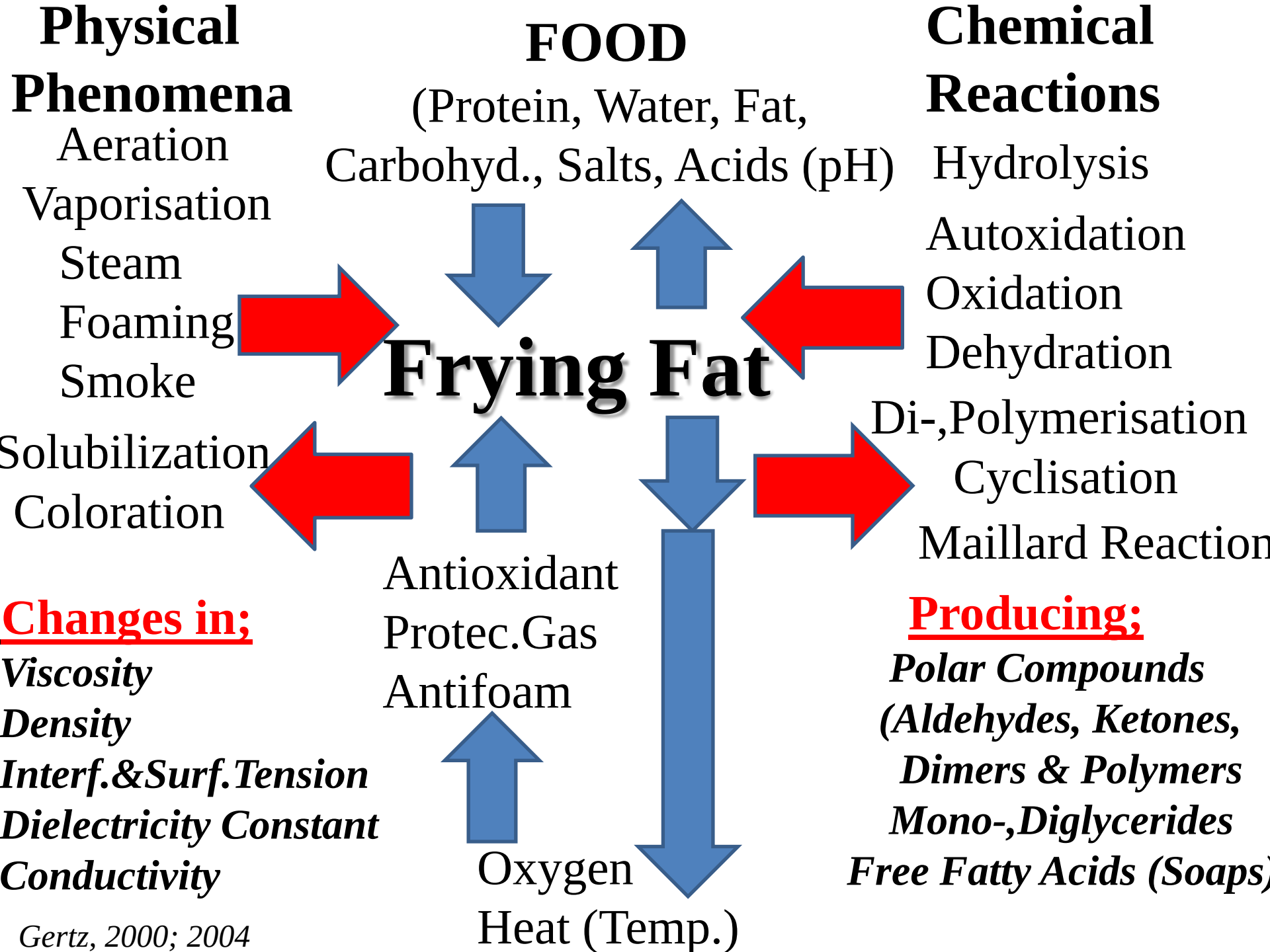
The reduction of the fat content in fried food is desirable, mainly owing to its relationship with obesity and coronary diseases.

Recently, it has been great interest in producing fried food with low content of acrylamide and fat.





Optimization of Frying Process


Physical Phenomena
Aeration
Vaporisation
Steam
Foaming
Smoke
Solubilization
Coloration
FOOD
(Protein, Water, Fat, Carbohyd., Salts, Acids (pH)
Chemical Reactions
Hydrolysis
Autoxidation
Oxidation
Dehydration
Di-,Polymerisation
Cyclisation
Maillard Reaction
Frying Fat
Antioxidant
Protec.Gas
Antifoam
Oxygen
Heat (Temp.)
Changes in;
Viscosity
Density
Interf.&Surf.Tension
Dielectricity Constant
Conductivity
Producing;
Polar Compounds
(Aldehydes, Ketones,
Dimers & Polymers
Mono-,Diglycerides
Free Fatty Acids (Soaps)
Gertz, 2000; 2004

Frying Quality

FOOD
- Composition & Nature
- Fried Food Quantity (kg/h)
- Continuous OR Intermittent Frying

FRYER
- Capacity & Surface
- Fryer Temperature
- Heat Transfer Mode
- Metal Type in Contact with Fat

OIL
- Nature
- Thermostability
- Fresh Oil Addition

OTHERS
- Protective Gas
- Antifoams as Additive
- Antioxidants as Additive
- Using Filter Aids

Gertz, 2000; 2004

Regarding Important Quality Characteristics For Frying Oils

Frying Oil Quality → ***Fried Food Quality***

- ✓ *Oxidative Stability,*
- ✓ *High Smoke Point*
- ✓ *Low Foaming*

Recently;
The Optimization of Frying is most important

Improving of Frying

- ***Alteration of Frying Temperature***
- ***Substitution By Healthy Oils***
- ***Filtration of Using Oils and Adsorbent Treatments***
- ***New Frying Oils with Various Additives (Healthier Fatty Acid Profile Higher Heat Stability)***

Regarding Innovative Frying Oils

The innovative frying oils should have a nutritional value with high heat stability and a low content of saturates and *trans* fatty acids.

Improving Performance During Frying

- ***With Emulsifiers,***
- ***With Anti-polymerising Agents,***
- ***With Natural and Synthetic Antioxidants***

Gertz, 2004

■ Anti-Polymerising Agents &Reac.Products

Substance	Reaction Products (RP)	Formation Temp.
Tocopherols	Dimeric Tocopheryl-RP (C-O-C linked)	~80 ˚C
α-Tocopherol	Trimeric Compounds (C-C linked)	~150 ˚C
Squalene	Squalene Hydroxyperoxides	~100 ˚C
	Squalene Hydroxide	~100 ˚C
	Tetracyclosqualene	~170 ˚C
Phytosterols	Sterol Oxides	~100 ˚C
Sesamolin	Sesamol /Sesamin	~120 ˚C
	Sesaminol Isomers	~120 ˚C
Ascorbyl Palmit.	Dehydro Ascorbyl Palmit.	~130 ˚C
Phytosterols	Steradienes	~150 ˚C

Gogolewski et.al.,2003; Assunta Dessi et.al.,2002; Abou-Gharbia et.al.,2000; Fukuda et.al.,1986

Filter Aids and Adsorbents

Adsorbent/filter aid	Trade name
Minerals:	
Calcium silicate/Magnesium silicate	HubersorbR 600, Magnesol® XL
Sodium silicate	Britesorb® F100, C201
Perlite/citric acid/ water	Frypowder®
Silica	TriSyl®
Bentonite	Tonsil® 314FF
Organic materials	
Cellulose/citric acid	Maxfry® Filter Aid
Cellulose/charcoal	SuperSorb® CarbonPad

Gertz, 2004

Organic Acid & Antioxidant Additives

Organic Acids	Code	Max.Amount
Lactic acid	E270	Quantum satis
Citric acid and salts	E330, E331, E332, E333	Quantum satis
Antioxidants		
Ascorbic acid	E300	Quantum satis
Ascorbic palmitate	E304	Quantum satis
Tocopherols	E306, E307, E308, E309	Quantum satis
Gallates (propyl, octyl)	E306, E307	200 mg/kg
Dodecyl gallate	E308	100 mg/kg
BHA	E320	200 mg/kg
BHT	E321	200 mg/kg
TBHQ	E310	Not permitted in the EU

Gertz, 2004

Emulsifiers & Other Additives

Emulsifiers	Code	Max.Amount
Mono- and diglycerides of fatty acids	E471	10 g/L
Citric ester of mono- and diglycerides	E472c	Quantum satis
Antifoam		
DMPS	E900	10 mg/kg
Anti-Spattering Agent		
Lecithin	E322	30 g/L

Gertz, 2004

Commercially Available Frying-Oil Stabilising Formulations - I

Product	Composition	Addition
RE08	Rosemary extract, E472c, E471	1%
RE09	Rosemary extract, polyoxy ethylene, sorbitan mono-oleate, E472c, E471	1%
G1021	Ascorbyl palmitate, tocophe-rol extract, E472c, E471	1%
G1029	Ascorbyl palmitate, tocophe-rol extract, E472e, E471	1%
Good-Fry Constituents	Rice bran, sesame oil	6%
Good-Fry Plus	Rice bran, sesame oil, toco-pherols, E472c, E471	6%
Oilmaster	Ascorbyl palmitate, tocophe-rol extract, E471, E472c,	0.4%

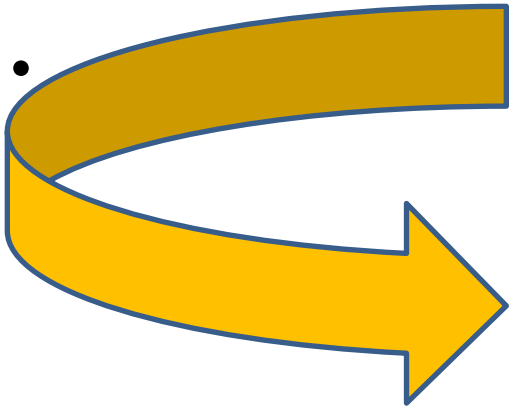
Gertz, 2004

Commercially Available Frying-Oil Stabilising Formulations - II

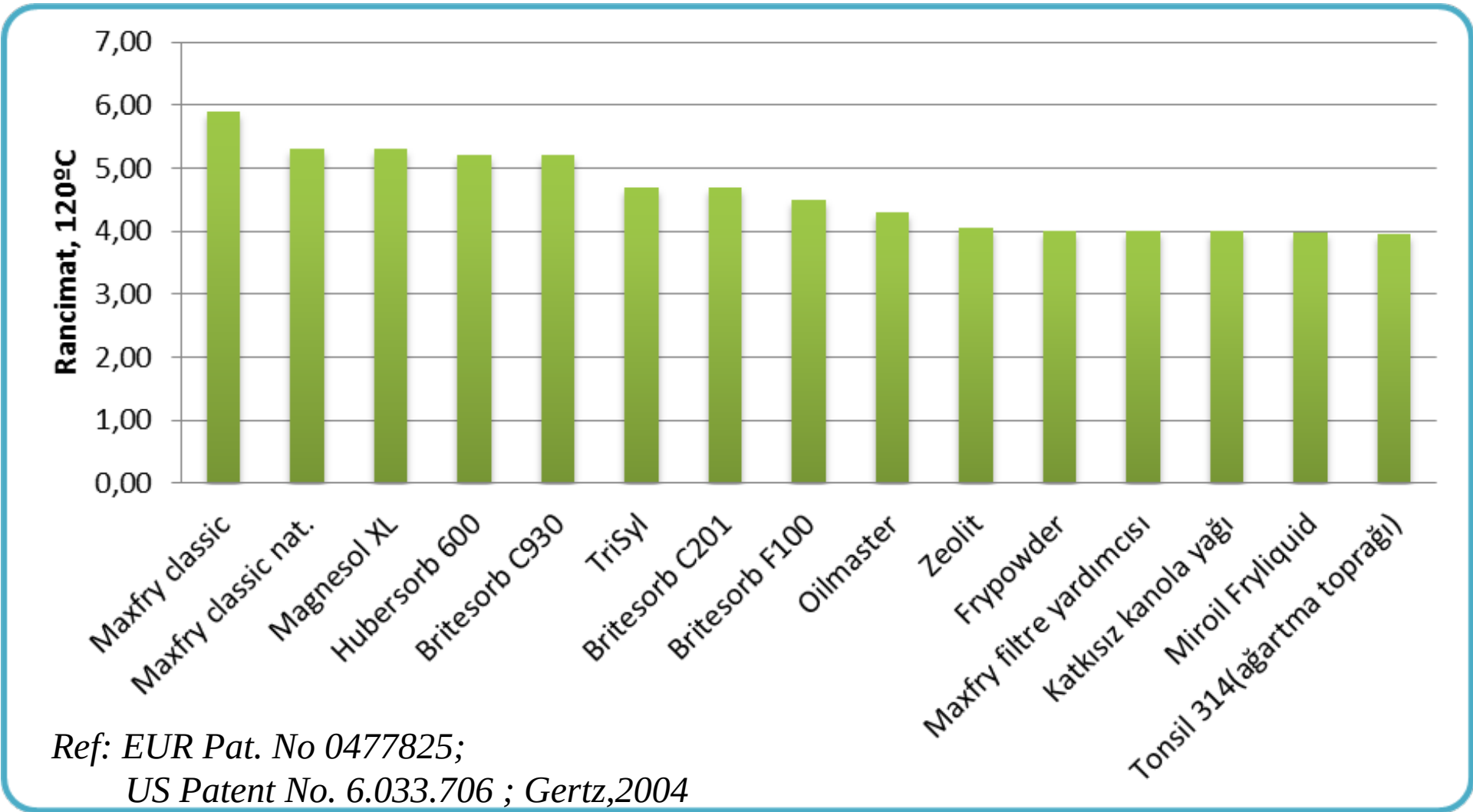
Product	Composition	Addition
Miroil Fryliquid	Citric acid, water, rosemary extract, curcuma, E472b, lecithin, ascorbic acid (labelled, but not found analytically).	0.5%–1%
Maxfry Classic nat	Rice bran, sesame oil, E471, E472b, E472c, natural extracts, citric acid	0.5%
Maxfry Classic	vegetable oil, tocopherol extract, ascorbic palmitate, E471, E472b, E472c, citric acid	0.5%

Gertz, 2004

Many stabilising liquid preparations contain both emulsifiers and antioxidants…



MAXFRY® classic nat (MFN), is a mixture of the emulsifiers 471 and 472b/c, citric acid and a heat-stabilising system derived from specially refined sesame oil, rice bran oil and other natural antioxidants



Ref: EUR Pat. No 0477825;
US Patent No. 6.033.706 ; Gertz,2004

This aim of our research was to investigate the effect of innovative fortification system consist of selected adsorbent, emulsifiers, antifoam and selected antioxidants on some frying characteristics and less oil uptake of fried potato and fried eggplant.

Research Materials

- Frying Oils; Sunflower Oil, Refined Palm Oil were obtained from YONCA Oil Company, Manisa.
- Fresh potatoes and egglants were purchased from the local market by Celal Bayar University Researc Fund Project 2012-031. Hunnap (Ziziphus) extract was obtained at CBU By Manisa Demirci Municipality
- Frying Oil Additives; Antioxidants, Emulsifiers and Antifoam were purchased from *Süd-Chemie* (München, Germany), from BruCem Inc.,USA by CBU Project-Turkey Maxfry® was obtained by Dear Dr Gertz,Hagen,Germany for our training analyses
- For filter aid, the adsorbent Calcium Silicate ‘’Commercial : Hubersorb 600 (HB600) ‘’ was obtained from *J. M. Huber* Corp. (Havre de Grace, MD, USA) through Sarmal Kimya Tic. Ltd. Şti,Istanbul).

Innovative Frying Additive

Liquid Additive in Frying Oil

0.5 wt-%

"CBUFry" Oil-1 *CBU-BAP Project-2012-031*

Antioxidants

Extracts of rosemary- **E392** 0.75 mg/kg

Alpha-Tocopherol- **E306** 0.75 mg/kg

Lutein (β,ε-carotene-3,3'-diol)- **E161b** 0.75 mg/kg

Citric Acid- **E330** 0.5 mg/kg

Ascorbyl palmitate- **E304** 1 mg/kg

Emulsifiers

Mono-and diglycerides of fatty acids- **E 471** 3 g/L

Lactic Acid Esters of Mono and Diglycerides (LACTEM) **E472b** 2 g/L

Antifoam

Dimethypolysilozane-DMPS**E-900** 1 mg/kg

Innovative Frying Additive

Liquid Additive in Frying Oil

0.5 wt-%

"CBUFry" Oil-2

CBU-BAP Project-2012-031

Antioxidants

Extracts of rosemary- **E392** 0.75 mg/kg

Alpha-Tocopherol- **E306** 0.75 mg/kg

Citric Acid- **E330** 0.5 mg/kg

Ascorbyl palmitate- **E304** 1 mg/kg

Hunnap Extract-(NA) 0.75 mg/kg

Emulsifiers

Mono-and diglycerides of fatty acids- **E 471** 3 g/L

Lactic Acid Esters of Mono and Diglycerides (LACTEM) **E472b** 2 g/L

Antifoam

Dimethypolysilozane-DMPS**E-900** 1 mg/kg

Frying Equipment

A deep frying unit, the electric fryer, was from ***Tefal Actifry Plus*** **,** TEFAL, Turkey and had a capacity of 1 L.

For Potato Preparation to Frying;

Prior to frying, potatoes were peeled, thoroughly washed, wiped, and cut in approximately uniform pieces a (8 × 8 × 60 mm) strips. The strips were divided into three portions.

The sliced potatoes were weighed into 100-g portions and soaked in a 2.5% NaCl solution for 5 min.

(*This application was to reduce the oil absorption capacity and to prevent the surface darkening of the potato slices owing to oxidation). Besides positively affects the surface properties (improves the rigidity of potato slices by complexing pectin.*

For EggPlant Preparation to Frying;

Prior to frying, eggplants were peeled, thoroughly washed, sliced in round pieces with 6–7 cm diameter, and a thickness of 1 cm and 0.3 cm, respectively. Eggplants were also fried blanketed with wheat flour (about 13 g), representing 5–8% w/w of the fresh eggplants.

For Potato & EggPlant Frying

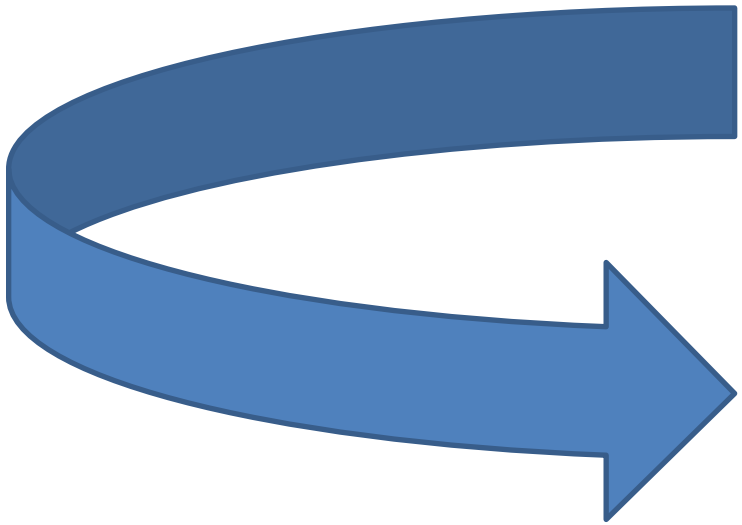
Temperature was not allowed to exceed 180°C and the fried foods were removed from the frying pan as soon as they were uniformly cooked without external burnings

FRYING 180 ˚C for 6 min

in sunflower oil

Fried samples were homogenizated (about 100g for each) and oil analyses were done.

Samples of fresh and fried oils were kept under nitrogen in screw-capped vials at −20°C until analysis.



Quality Analyses

The amount of water loss and oil absorption, the weight of both oil and fried samples before and after frying was recorded.

Moisture content. **The initial moisture content was determined by drying approximately 5 g of raw potato slices and eggplant slices to a constant mass for 72 h at 105 C (AACC, 1986).**

Oil content. **Oil content was measured by Soxhlet extraction using n-hexane (Southern, 2000). The test was performed in duplicate and average values taken.**

Total Polar M. **was performed acc.to AOCS (1999)**

Fatty acids, in the form of their methyl esters, were determined by GC in an aliquot of the lipid extract. (Tokuşoğlu,2003)

GC analyses Subsequent fatty acid profiles were analyzed by gasliquid chromatography.

The fatty acid methyl esters were analysed using a 60 m (with 0.25 mm film thickness), 0.25-mm inside-diameter WCOT fused-silica SGE (BP70X capillary GC column installed on a Perkin Elmer (Auto System) gas chromatograph with a flame ionization detector (FID)).

The gas chromatograph was temperature programmed to start at 120C (5 min isoterm) and to increase to 200C with 4C/min (5 min isoterm) (Ramp 1), then increase to 240C with 48C/min (25 min isoterm). Injector and detector temperatures were set to 250C. Carrier gas was helium at a flow rate of 1.0 ml/min and split ratio was 50:1. The samples were injected as 1 ml.

Total Polar Compounds Analyses

Color Analyses

Color measurement and evaluation; The color of potato and eggplant was measured by a chroma meter (Minolta Co., Japan). The three color parameters L, a, b of the sample were generated from the data processor.
where L0, a0 and b0 are the lightness, redness and yellowness color score, respectively, at time zero. The L, a and b represented the instantaneous individual readings during Frying.

Antioxidant Activity

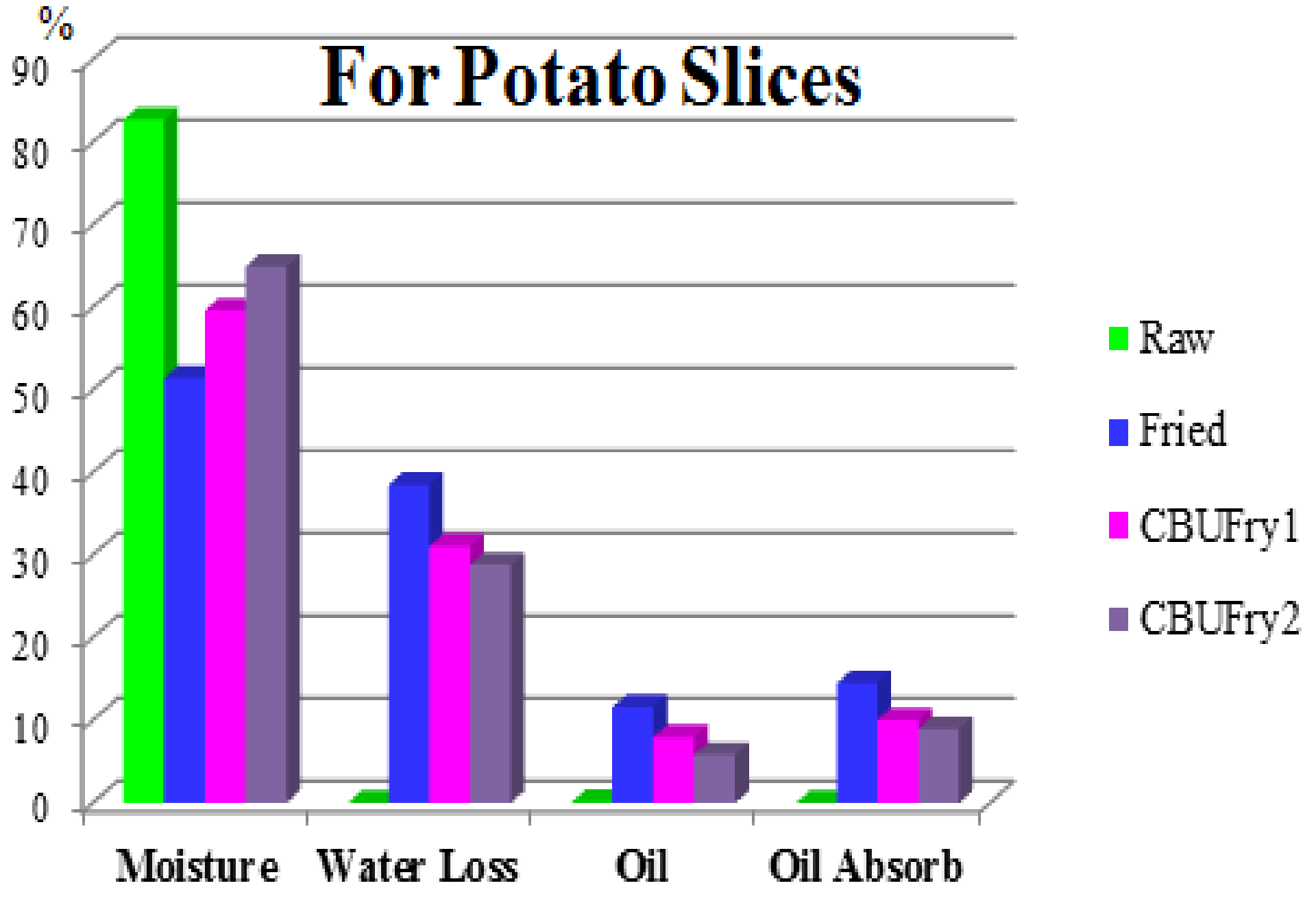
The Trolox equivalent antioxidant capacity (TEAC) assay (Pellegrini *et al*. 2003),

Results

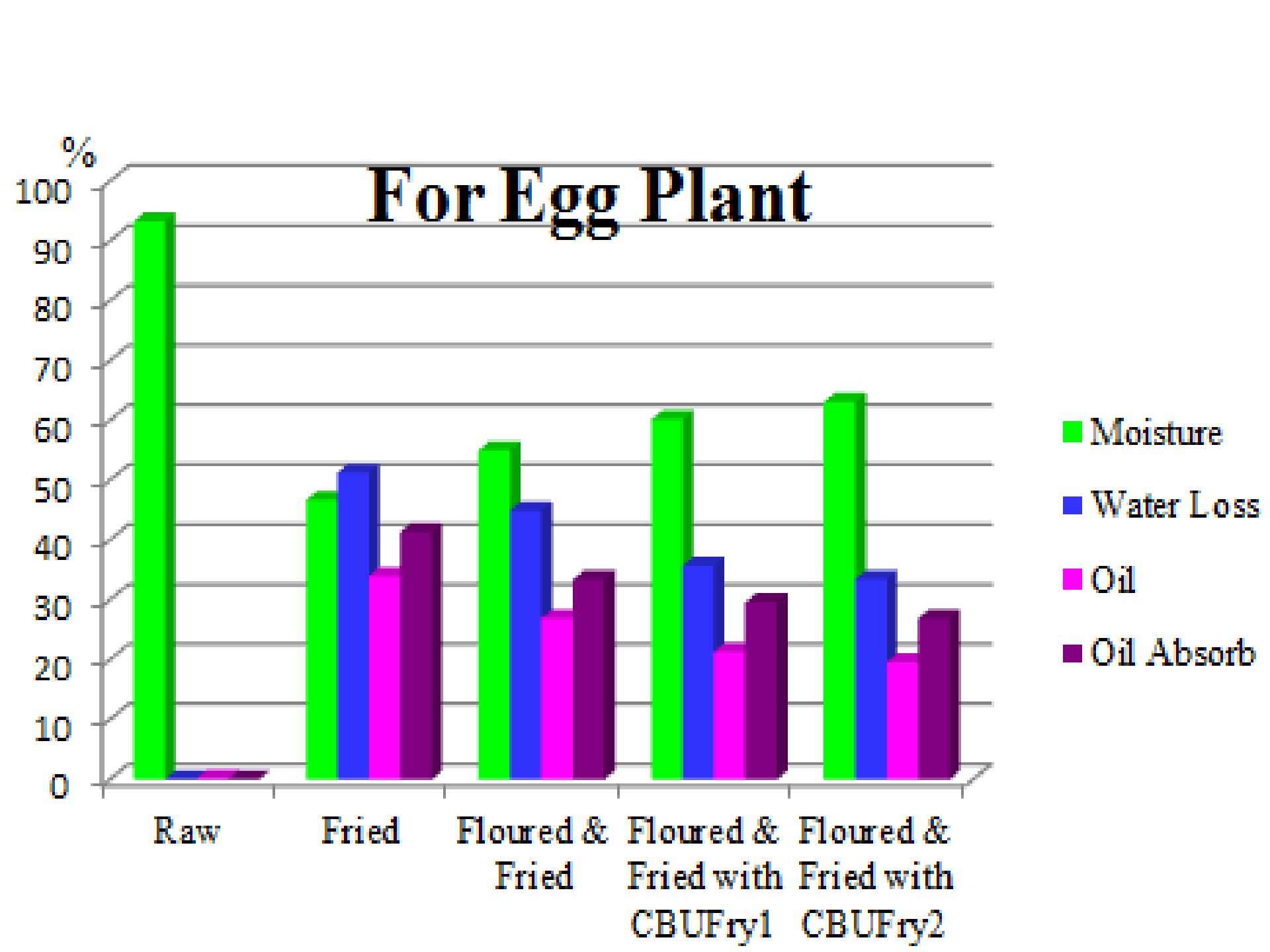
This is One Part of the Results of CBU-2012-031 Research Project

		Moisture (g/100g FW)	Water Loss (g/100g) A	Oil (g/100g)	Oil Absorbed (g/100g) B
Potato	Raw	82.72± 1.05	-	0.15±0.05	-
	Fried	51.42± 0.73	38.51± 0.91	11.63±0.88	14.5±1.01
	Fried with CBUFry 1	59.63± 0.98	31.07± 0.48	7.98± 0.32	10.06±0.83
	Fried with CBUFry 2	64.95± 1.16	28.82± 0.48	5.84± 0.50	8.96±0.39

fw: fresh weight; A = 100 × [C − (D − E)]/C; B = 100 × E/D; where C = vegetable before frying (g), D = vegetable after frying (g), E = oil absorbed (g) = oil before frying – oil after frying.

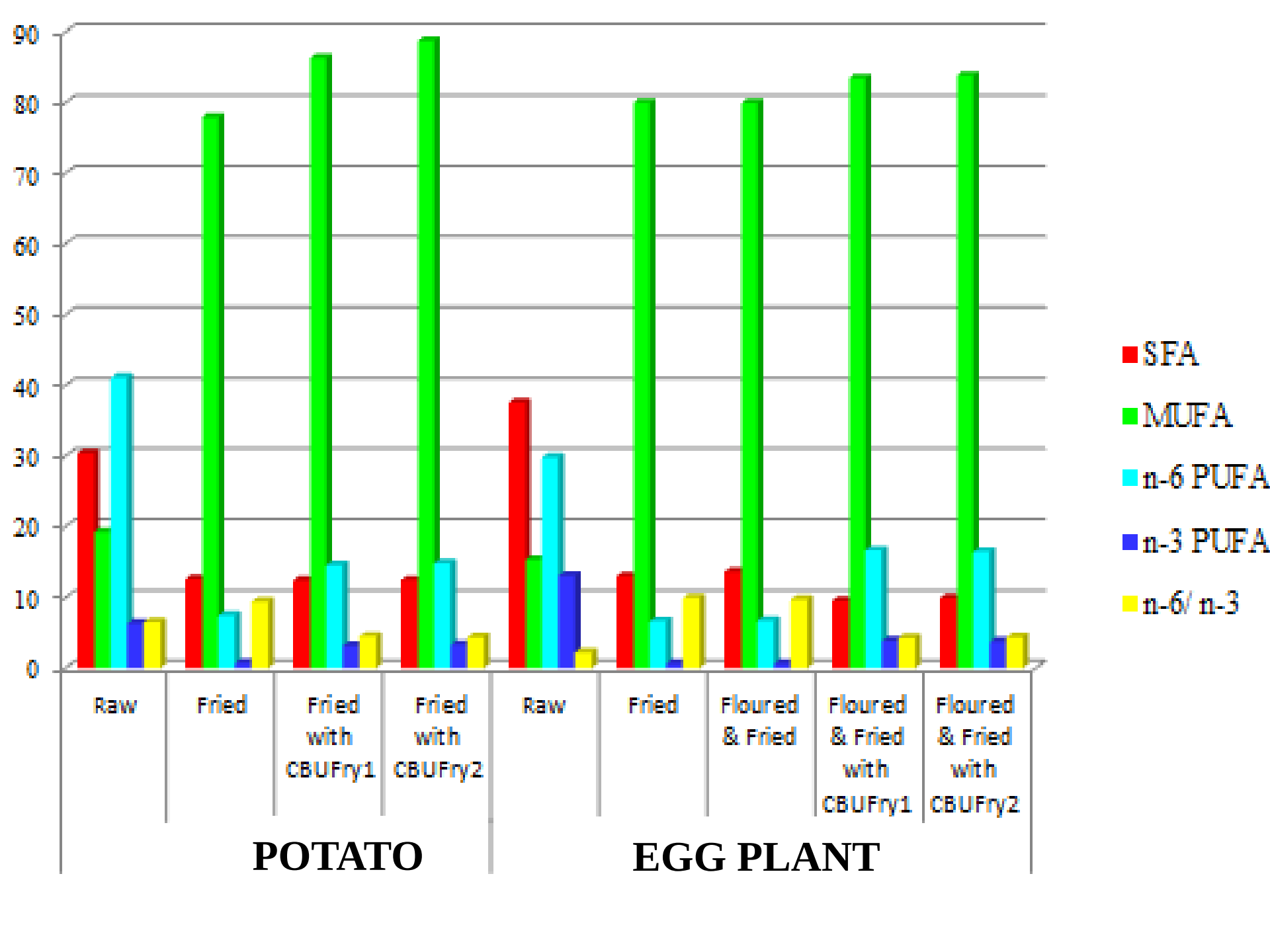

For Potato Slices
%
90
80
70
60
50
40
30
20
10
0
Moisture
Water Loss
Oil
Oil Absorb
Raw
Fried
CBUFry1
CBUFry2

		Moisture (g/100g FW)	Water Loss (g/100g) A	Oil (g/100g)	Oil Absorbed (g/100g) B
Egg Plant	Raw	93.23± 1.90	-	0.13±0.05	-
	Fried	46.70± 0.92	51.25±0.52	33.97±1.56	41.35±1.25
	Floured & Fried	55.03± 0.42	44.94±0.23	26.87± 2.03	33.40±1.06
	Floured & Fried with CBUFry1	60.15± 0.88	35.70±0.56	21.34± 1.42	29.61±0.83
	Floured & Fried with CBUFry2	63.06± 0.51	33.45 ±0.85	19.56± 1.07	26.89±0.50


For Egg Plant
%
100
90
80
70
60
50
40
30
20
10
0
Raw
Fried
Floured & Fried
Floured & Fried with CBUFry1
Floured & Fried with CBUFry2
Moisture
Water Loss
Oil
Oil Absorb

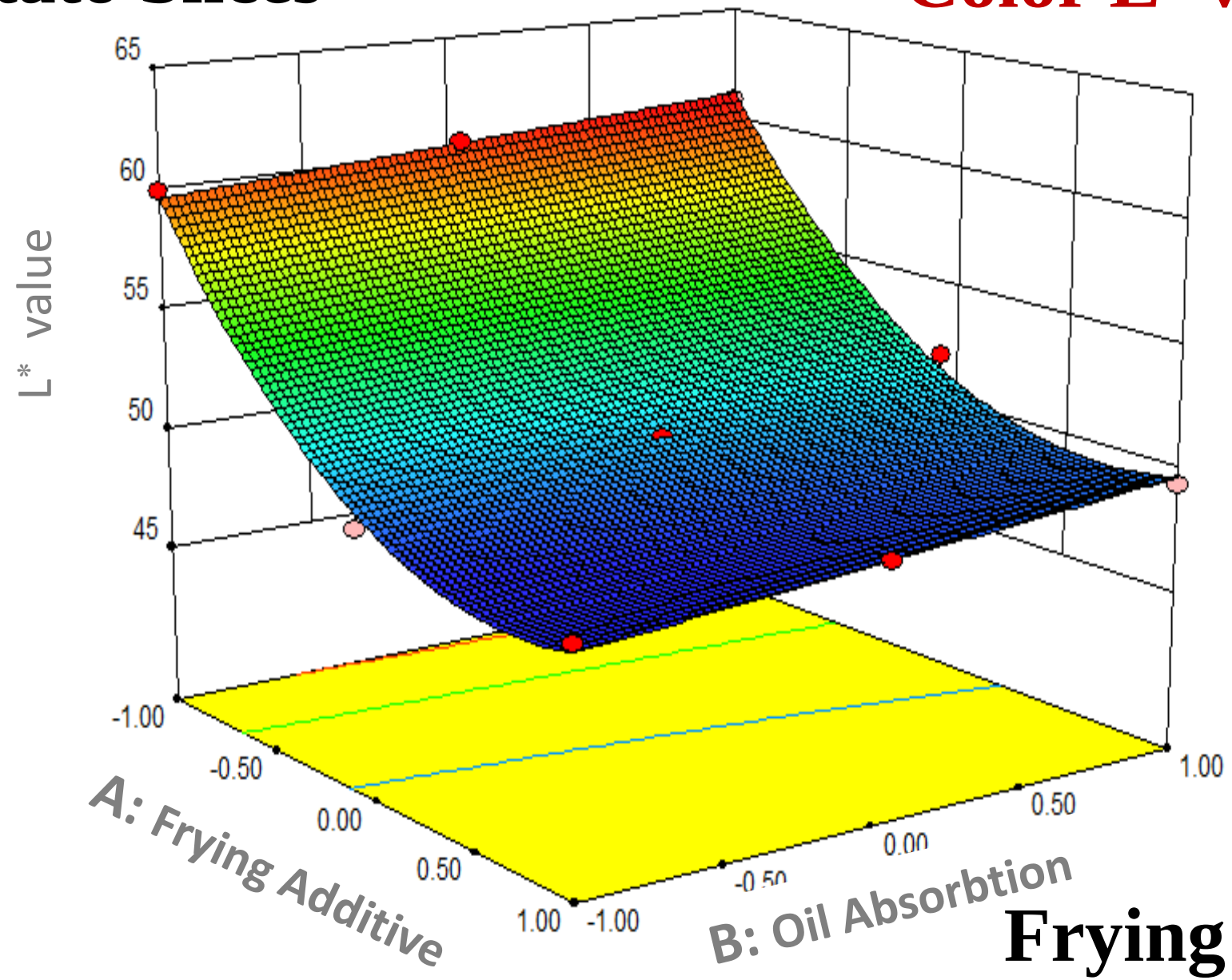
		SFA	MUFA	n-6 PUFA	n-3 PUFA	*n*-6 / *n*-3
Potato	Raw	30.42	19.26	41.17	6.32	6.51
	Fried	12.57	77.92	7.48	0.79	9.47
	Fried with CBUFry 1	12.43	86.32	14.56	3.23	4.51
	Fried with CBUFry 2	12.45	88.78	14.84	3.38	4.39
EggPlant	Raw	37.57	15.33	29.85	13.07	2.28
	Fried	13.03	80.04	6.69	0.67	9.98
	Floured & Fried	13.65	79.97	6.76	0.69	9.79
	Fried with CBUFry 1	9.58	83.45	16.72	3.89	4.29
	Fried with CBUFry 2	9.97	83.82	16.54	3.77	4.39

According to NCEP guidelines; In Total Diet; 25-35 % from oils
SFA <7 ; MUFA <20 ; PUFA <10

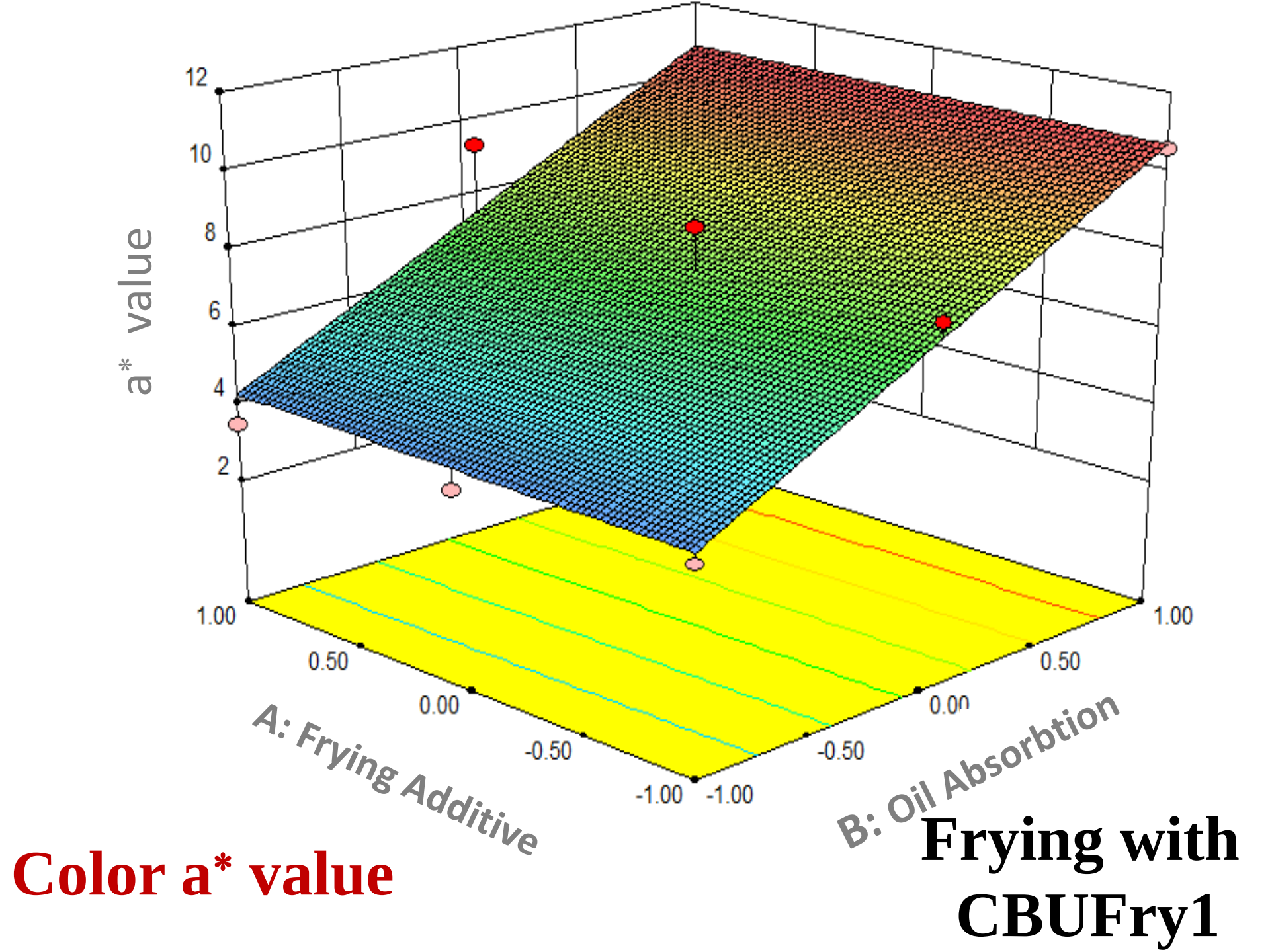

90
80
70
60
50
40
30
20
10
0
SFA
MUFA
n-6 PUFA
n-3 PUFA
n-6/ n-3
Raw
Fried
Fried with CBUFry1
Fried with CBUFry2
Raw
Fried
Floured & Fried
Floured & Fried with CBUFry1
Floured & Fried with CBUFry2
POTATO
EGG PLANT

Potato Slices

Color L* value

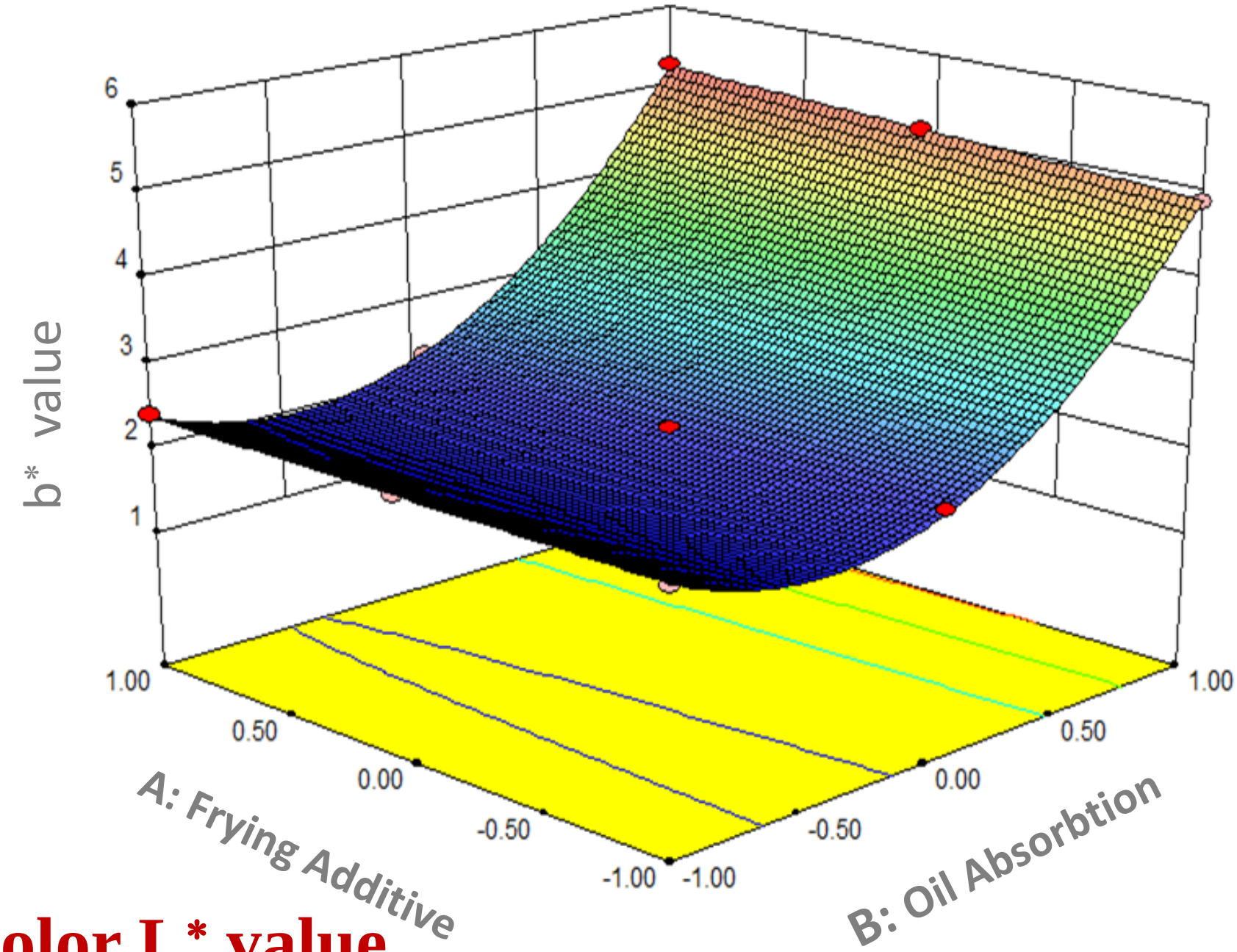


Frying with CBUFry1



Color a* value

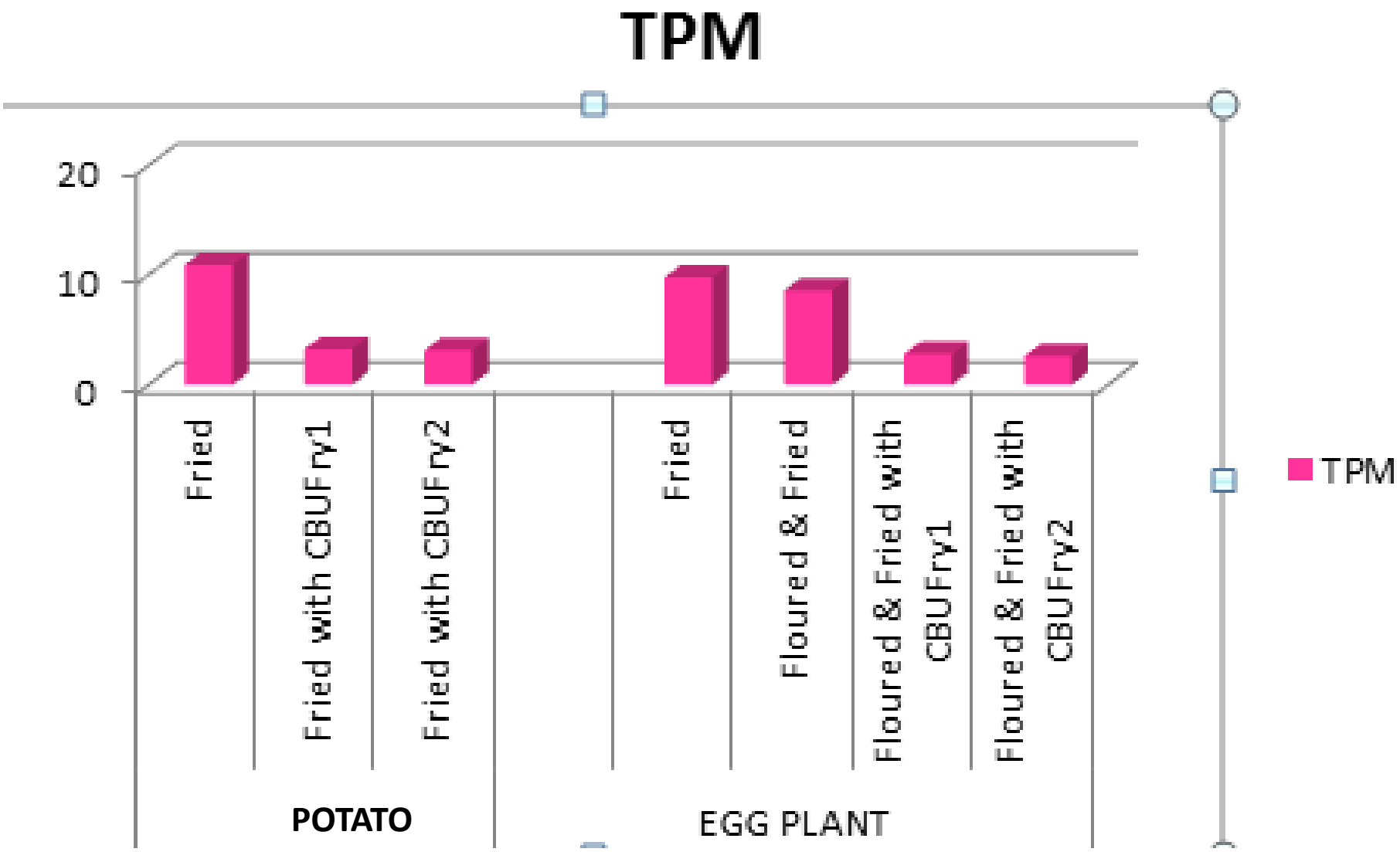
Frying with CBUFry1



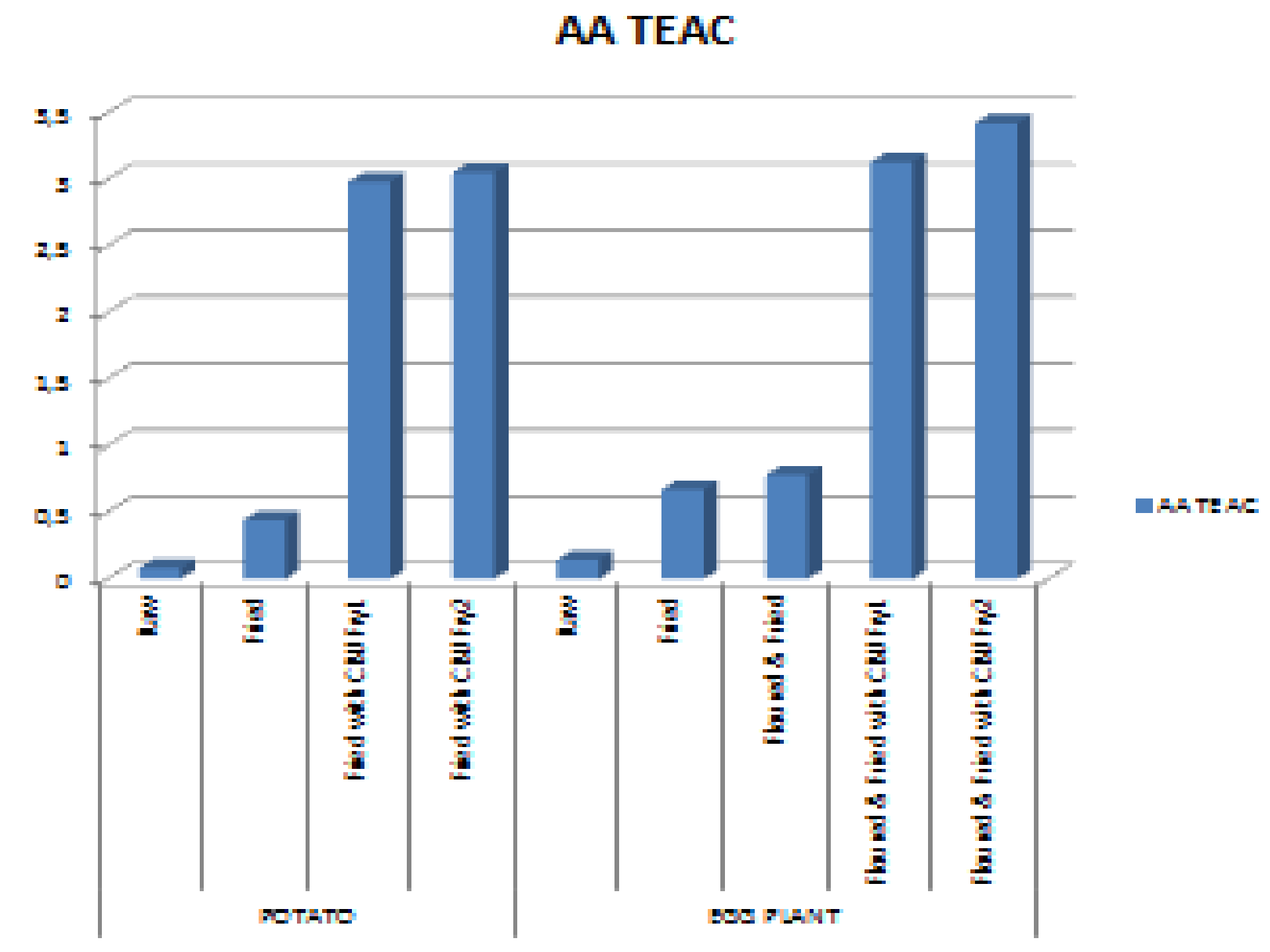
Color L* value

CBUFry1

		Total Polar M.(g/100 g MD)
Potato		
	Fried	10.89
	Fried with CBUFry 1	3.23
	Fried with CBUFry 2	3.10
EggPlant		
	Fried	9.76
	Floured & Fried	8.56
	Fried with CBUFry 1	2.74
	Fried with CBUFry 2	2.55


TPM
20
10
0
Fried
Fried with CBUFry1
Fried with CBUFry2
Fried
Floured & Fried
Floured & Fried with CBUFry1
Floured & Fried with CBUFry2
POTATO
EGG PLANT
TPM

		AA TEAC (mmol Trolox/100 g)
Potato	Raw	0.08
	Fried	0.44
	Fried with CBUFry 1	2.98
	Fried with CBUFry 2	3.05
EggPlant	Raw	0.14
	Fried	0.67
	Floured & Fried	0.78
	Fried with CBUFry 1	3.13
	Fried with CBUFry 2	3.42


AA TEAC
3,5
3
2,5
2
1,5
1
0,5
0
Raw
Fried
Fried with CMU Fyd
Fried with CMU Fyd
Raw
Fried
Raw oil & Fried
Raw oil & Fried with CMU Fyd
Raw oil & Fried with CMU Fyd
POTATO
EGG PLANT
AA TEAC

The Innovative CBUFry1 and CBUFry2 formulations improved the both fried oil and fried food quality .

The reduction of oil content accomplished as about 55 percent with two formulations aid ($p \leq 0.05$) and total polar compounds level decreased above 72% ($p \leq 0.05$).

Color L and b values increased at the fried potato slices and eggplant.

AA levels were higher than that of normal frying.

It was concluded that our innovation formulation provided the additional intake of monounsaturated fat

This proposed innovative fortification system CBUFry1 and CBUFry2 can be used for frying oils and can be adaptable to industrial frying oil technology. The further studies are in progress..

References

Bognár, A. **1998**. Comparative study of frying to other cooking techniques influence on the nutritive value. *Grasas Aceites*, 49 250–260

Fillion, L., C. J. K. Henry. **1998**. Nutrient losses and gains during frying: a review. *International Journal of Food Science and Nutrition*, 49, 157–168.

Boskou, D., & Visioli, F. **2003**. Biophenols in table olives. In M. P. Vaquero, T. Garcia-Arias, & A. Garbajal (Eds.) Bioavailability of micronutrients and minor dietary compounds. Metabolic and technical aspects. Research Signpost.

Gertz C. **2004**. Optimising the baking and frying process using oil-improving agents. *Eur. J. Lipid Sci. Technol.* 106, 736–745

Gertz C. **2000**. Chemical and physical parameters as quality indicators of used frying fats**.** *Eur. J.Lipid Sci. Techn.* 102, 566-572.

Gogolewski M., M. Nogala-Kalucka, G. Galuba: **2003**. Studies on dimerisation of tocopherols under the influence of methyl linoleate peroxides. Nahrung/Food **47,** 74–78.

*Assunta Dessi M., M. Deiana, B.W. Day, A. Rosa, S. Banni, F. P. Corongiu***: 2002**. Oxidative stability of polyunsaturated fatty acids: effect of squalene. Eur. J. Lipid Sci. Technol. **104**, 506–512.

Fukuda Y., N. Nagata, T. Osawa, M. Namiki: **1986**. Chemical aspects of the antioxidative activity of roasted sesame seed oil, and the effects of using the oil for frying. Agric. Biol. Chem. **50,** 875–862.

Abou-Gharbia H.A., A. A. Y. Shedata, F. Shahidi **2000.** Effect of processing on oxidative stability and lipid classes of sesame oil. Food Research International **33** , 331–340

European Patent No 0477825, US Patent No. 6.033.706.

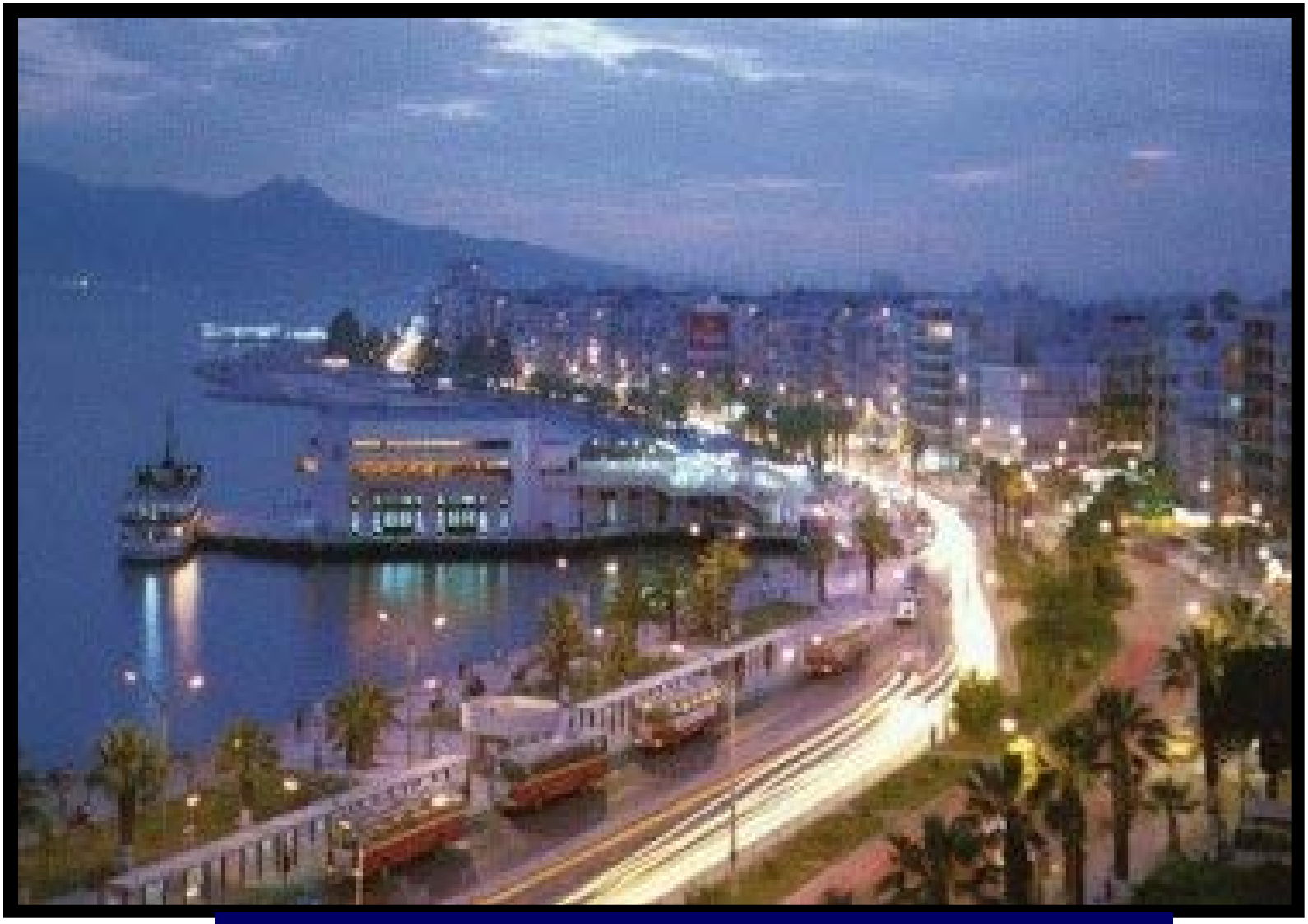
Pellegrini N, Serafini M, Colombi B, Del Rio D, Salvatore S, Bianchi M, Brighenti F. 2003a. Total antioxidant capacity of plant foods, beverages and oils consumed in Italy assessed by three different in vitro assays. J Nutr 133:28122819.

THANK YOU FOR YOUR INTERESTS

GREETINGS FROM


MANISA


TURKEY –İZMİR
AYKUT FIRAT



İZMİR- KARŞIYAKA

WISHING SUCCESFULL OMICS CONFERENCES

SEE YOU NEXT MEETING

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