RHEOLOGICAL STUDY ON ICE CREAM

By

YASSER FAROUK HASSAN ABD EL-GHANY
B.Sc. Agric. Sci. (Dairy Science), Fac. Agric., Cairo Univ., 1993
M.Sc. Agric. Sci. (Dairy Science), Fac. Agric., El-Azhar Univ., 2002

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Sciences
(Dairy Science)

Department of Dairy Science
Faculty of Agriculture
Cairo University
EGYPT

2016

APPROVAL SHEET

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Approval: 12 /5/ 2016

ABSTRACT

This work was implemented to study the effect of whey protein concentrate (WPC), whey protein isolate (WPI) and glycomacropeptide (GMP) as a partial substitution of milk solids not fat (MSNF) in ice cream formula by 1, 2, 3 and 4% of (MSNF). Mixes and resultant ice cream samples were analyzed for their chemical, physicochemical and rheological properties as well as the sensory quality attributes. There was no remarkable effect of adding whey proteins as partial substitution of MSNF on total solids or fat percentages, while total protein, ash, and lactose content were significantly affected. Specific gravity was significantly affected with the ratio of substitution in both mixes and resultant ice cream and therefore the weight per gallon and overrun percent were significantly changed in the samples. Apparent viscosity as well as flow time of mixes were significantly increased. Flow behavior was also affected showing higher yield stress. Increasing WPC, WPI and GMP in ice cream mixes resulted in a building up of structure leading to increase in the sample viscosity. The shear stress increased significantly with increasing the substitution ratio. Also, flow behavior index (n) decreased by increasing the substitution levels of whey proteins. The consistency coefficient (k) was more affected by the presence of whey proteins in the recipe than the flow behavior index. Herschel-Bulkley behavior (building up of structure and increasing of sample viscosity) was observed in ice cream mix by increasing the substitution levels of whey proteins. Back-extrusion results represented a decrease in hardness values of resultant ice cream, while, during storage, there was a slight increase. Energy input values decreased by increasing substitution levels of whey proteins. During storage, there was a low significant increase of energy input values. The energy output negatively correlated with substitution levels of whey proteins and positively with storage period indicating a strong structure for stored ice cream. Load at target deformation (50%) applied to the samples showing decreased values proportional to increasing substitution levels of whey proteins in ice cream samples when fresh and after 14 days storage. The resilience showed decreased ratio indicating more visco-elastic properties in fresh ice cream. The recovered height and deformation increased with increasing substitution levels of whey proteins and storage period. Therefore, more sticking properties were obtained in resultant ice cream. Adhesive force decreased significantly with increasing substitution levels of whey proteins and storage period. Adhesiveness values were significantly higher in all treatments than control and increased gradually during storage.

Key words: whey protein concentrate, whey protein isolate, glycomacropeptide, rheological properties, Ice cream, texture profile analysis, Back extrusion.

ACKNOWLEDGEMENT

Deepest, greatest and sincere thanks to ***ALLAH*** *the most Merciful, Great and Clement God.*

I gratefully wish to express my deepest gratitude and infinite thanks to my supervisor ***Prof. Dr. Hoda Mahmoud El-Zeini*** *Professor of Dairy Science, faculty of agriculture, Cairo University. I would like to thank her for her great supervision, highly kindness, guidance as well as help writing of the manuscript of this work and her effort in statistical analysis and help in the rheological measurement, which exceptionally inspired and enriched my growth as a researcher.*

I would like to express my second thanks to ***Prof. Dr. Monier Mahmoud Ibrahim El-Abd*** *Professor of Dairy science, Faculty of Agriculture, Cairo University, for his supervision, and guidance through the course of study which give the work great value.*

My deep appreciation for ***Prof. Dr. Abdel-Rahman Abdel-Atti Ali****, Professor of Dairy science, Faculty of Agriculture, Cairo University, for his help in writing the manuscript and guidance throughout the course of study.*

I would like also to express my gratitude and appreciation to ***Prof. Dr. Moustafa Abd El-Moneam Zedan*** *professor of Dairy science, Food Technology Institute, Agricultural Research Center, Ministry of Agriculture, for his help offering facilities to accomplish lab. work.*

Sincere thanks goes to Dr. ***Rezk Azab Awad*** *Professors of Dairy Science, Faculty of Agriculture, Ain Shams University, for his help at the early stage of the lab work and continuous assistance throughout the investigation. He taught me several things which I never have the opportunity to learn. It is too difficult for me to express my deep respect to him.*

Thanks also to everybody who provided, help or advice to achieve this manuscript.

LIST OF ABBREVIATIONS

"	Inch
%	percent
&	And
<	Less than
±	Plus or minus
®	Trademark
AOAC	Association of Official Analytical Chemists
C	Celsius
CMC	Carboxymethyl Cellulose
Co.	Company
CSS	Corn Syrup Solids
CV	Coefficient of Variation
DE	Dextrose Equivalent
DF	Degree of freedom
e.g.	For example
FAO	Food and Agriculture Organization
Fig.	Figure
FP	Freezing point
g	gram
gal	(1 U.S. gallon = 3.785 litre, 1 U.K. gallon=4.546 litre)
HTST	High temperature short time
J	Joule
K	Consistency index
kDa	Kilo Dalton
kg	Kilogram
lbf	Pound force; (1lbf = 4.448N = 0.4536 kgf)
LSD	Least significant differences
mEq	Millie equivalent
min	Minute
mJ	Milli joule
ml	Milliliter
mm	Millimeter
MPC	Milk protein concentrate
MS	Mean Square
MSNF	Milk solid not fat
MW	Molecular weight
n	Shear rate index
N	Newton; (1 N = 0.225 lbf)

Na^+	Sodium cation
nm	Nano meter
^{o}	Degree
P	page
p.p.m	Part per million
PI	Protein isolate
pI	Isoelectric point
Prob.	Probability
qt	Quart
r	Regression coefficient
r.p.m	Round per minute
R^2	Multiple R
sec.	Second
Sp.gr	Specific gravity
TA	Titratable acidity
TC	Total calcium
temp.	Temperature
T_f	Freezing point temperature
TP	Total protein
TPA	Texture Profile Analysis
TS	Total solids
UF	Ultra filtration
UV	Ultra violet
v	volume
wk	week
WPC	Whey protein concentrate
WPI	Whey protein isolate
wt/wt	Weight by weight
α	Alpha
β	Beta
γ	(Gamma) Shear rate
η_a	(Eta) apparent viscosity
κ-casein	Kapa casein
μg	Microgram
σ	Shear stress

CONTENTS