

**STUDIES ON MODIFIED BUFFALOES
MILK FAT**

By

TAMER SHAABAN ABDUL ALIM ABDUL HAMID
B.Sc. Agric. Sci. (Dairy Science), Fac. Agric., Cairo Univ., 2003

THESIS

**Submitted in Partial Fulfillment of the
Requirements for the Degree of**

MASTER OF SCIENCE

In

**Agricultural Sciences
(Dairy Science)**

**Department of Dairy Science
Faculty of Agriculture
Cairo University
EGYPT**

2020

Format Reviewer

Vice Dean of Graduate Studies

Name of Candidate: Tamer Shaaban AbdulAlim

Degree: M.Sc.

Title of Thesis: Studies on Modified Buffaloeses Milk Fat

Supervisors: Dr.Fatma Ramadan Metwally

Dr.Elham Mostafa ElSayed

Dr. Abeer Fouad Zayan

Department: Dairy Sciences

Approval: 15/06/2020

ABSTRACT

Buffaloes Milk fat has excellent properties, variable physicochemical properties but its lack of functionality which restrict its uses in food industry. The study was designed to fractionate the buffaloes butter oil (BO) at different temperature (35-15^oC) by multi-step dry fractionation to gain three solid fractions (S35, S25, S15) and three liquid fractions (L35, L25, L15). Chemical properties, fatty acids composition, solid fat content (SFC), thermal behavior, texture and microstructure of its fraction was implemented. In addition, production of modified butter spread (MB_s) by using various proportion of milk fat fractions as follow: L15, L25, S25 at ratio (6:3:1 and 7.5:1.5:1), L15:L25: L15 (7:2:1and 8:1:1) and L15:S15: S25(7:2:1) for MB1, MB3, MB2, MB5 and MB4 respectively during cold storage at 5^oC. The physicochemical, oxidation stability, thermal analysis, texture and sensory properties were also studies.

The results indicated that L15 has the lowest SFC, AI, melting and crystal temperature, whereas recorded the highest MUSFA, PUSFA, PUFA/SFA ratio and $\omega_6.\omega_3$ ratio to compared with other fractions and two control(BF&CB). An increasing the L15 level in MB_s samples the MUSFA, PUSFA, spreadable index, $\omega_6.\omega_3$ ratio and DPPH was observed .The MB5 sample had gained the highest sensory attributes when fresh or during at 5^oC 90 days.

It can be concluded that functional properties and nutritional value of BO fractions and its products were achieved. Both products can be recommended in functional food preparations.

Key words: Buffaloes butter oil, dry fractionation, Thermal analysis, fatty acids, modified butter and crystals morphology

CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	5
1. Buffaloes Milk Fat	5
1.1 Milk Fat Composition.....	6
1.1.1 Structure of Milk Fat Globule Membrane.....	6
1.1.2 Fatty Acids Profile.....	7
1.2 Modification of milk fat	10
The role of milk fat modification.....	11
Goals and advantage of dry fractionation.....	12
1.2.1 Technological methods of milk fat modification.....	13
1.2.2 Physical modification of milk fat.....	13
A. Dry fractionation techniques.....	15
B. Dry fractionation by solvents.....	18
1.2.3 Chemical modification.....	19
A. Hydrogenation process.....	19
B. Inter-esterification process.....	20
1.2.4 Cholesterol reduction.....	21
A. Short path distillation.....	21
B. Supercritical fluids fractionation.....	23
2.2.5 Feeding modification.....	25
1.3 Physical properties of milk fat and obtained fractions	28
1.3.1 Thermal behavior by DSC & polymorphism.....	28
1.3.2 Solid fat content.....	40
1.3.3 Oxidative stability	42
1.3.4 Flavor	43
1.3.5 Textural characteristics.....	44
1.3.6 Microstructure	46
1.3.7 Nutritional aspects	47
1.4 Application of modified milk fat fractions	48

MATERIALS	AND	61
METHODS		
MATERIALS		61
A. Fresh butter.....		61
B. Butter milk powder.....		61
C. Skim Milk powder.....		61
D. Turmeric powder.....		61
E. Emulsion mixture.....		62
METHODS		63
A. Chemical Analysis		63
1. Determination of fatty acid.....		63
2. Total solids, protein and fat content.....		64
3. Calculation of the yield %.....		64
3. Calculation iodine value.....		64
4. Cholesterol content.....		64
B. Oxidation Stability		65
1. Peroxide value.....		65
2. Thiobarbituric acid value.....		66
3. The radical scavenging activity.....		66
4. Oxidation stability index.....		67
C. Thermal Analysis		68
1. Slip melting point.....		68
2. Solid Fat content.....		68
3. Differential scanning calorimetry.....		69
D. Microstructure analysis		70
E. Determination of texture profile		72
F. Sensory evaluation		72
G. Statistical analysis		72
EXPERIMENTAL PROCEDURES		74
A. Method of dry/multi-step fractionation		74
C. Modified butter spread preparation		75

RESULTS AND DISCUSSION	76
1. Improving the functional properties of buffaloes' butter Oil fractions obtained by multi-step dry fractionation	76
1.1 Yield.....	76
1.2 Slip melting point values.....	77
1.3 Iodine value.....	78
1.4 Cholesterol.....	78
1.5 Oxidative stability index.....	79
1.6 Fatty acid composition.....	80
1.7 Differential scanning calorimeter.....	83
1.8 Solid fat content.....	88
1.9 CLSM micrographs.....	90
1.10 Texture profile analysis.....	94
1.11 Correlation among SFC and (USFA, SCFA, MCFA, LCSFA, DSC and IV)	94
2. Modified butter blends (MBs) made using different ratio buffaloes butter oil fractions blend	95
2.1 Fatty acid composition of modified butter.....	96
2.2 Physiochemical properties of modified butter samples.....	102
2.3 Solid fat content	105
2.4 Oxidation stability.....	108
2.4.1 Peroxide value.....	108
2.4.2 Thiobarbituric Acid.....	111
2.4.3 The radical scavenging activity.....	113
2.5 Thermal behavior.....	116
2.6 Firmness and stickiness of modified butter.....	119
2.7 Sensory evaluation.....	122
SUMMARY	126
CONCLUSION	133
REFERENCES	135
ARABIC SUMMARY	1

LISTT OF TABLES

NO	Title	Page
1	Major fatty acids composition in milk fat.....	09
2	Different types of milk fat fractions used in preparation of modified butter spread (MB)	75
3	Physical and chemical properties of buffaloes' butter oil and its fractions	79
4	Fatty acid profile of both buffaloes butter oil and its fraction.....	82
5	Thermal parameters of crystallization, melting and their enthalpy of buffaloes' butter oil and its fractions.....	86
6	Solid fat content (g/100 g) of both buffaloes' butter oil and its fractions.....	89
7	Texture profile analysis (TPA) of buffaloes' butter oil and its fractions.....	94
8	Correlations among solid fat content and functional parameters...	94
9	Fatty acids composition of modified butter spread (MBs) (mg /100g).....	98
10	Chemical composition of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions.....	104
11	Solid fat content (g/100 g) of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions	107
12	Peroxide Value (PV) meq O ₂ /Kg fat of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions	109
13	Thiobarbituric acid value TBA (malonaldehyde mg/Kg fat) of modified butter spread (MBs) made with different ratio buffaloes	112

	butter oil fractions	
14	Radical scavenging activity (RSA%) of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions	115
15	Differential scanning calorimetry melting peak of modified butter spread (MBs)	118
16	Firmness and stickiness (N/mm) of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions	121
17	Sensory evolution of modified butter spread (MBs) made with different ratio buffaloes butter oil fractions	124

LIST of FIGURES

No.	Title	Page
1.	Structure of the fat globule of the main milk fat globule membrane (MFGM)	7
2.	Schematic diagram of goals of dry fractionation.....	12
3.	Advantage of dry fractionation for milk fat.....	12
4.	Technological methods of milk fat Fractionation.....	13
5.	The type of thermal fractionation process of AMF	18
6.	Typical differential scanning calorimetry (DSC) cooling and heating cycle of milk fat.....	28
7.	Melting profile of anhydrous milk fat.....	32
8.	Triacylglycerol molecule (a), polymorphism (b) and lamella stacking (c) of fat crystals.....	33
9.	Schematic illustration of polymorphic formation	36
10.	Schematic drawing of expected melting curves for a lipid in DSC	39
11.	Schematic diagram for fat fractions by multi-step dry fractionation procedure.....	74
12.	Schematic diagram for preparation of modified butter Spread	75
13.	DSC curves (cooling and heating) at rate 100C/min of buffaloes butter oil and its fractions.....	87

14.	Solid fat content (g/100 g) of both Buffaloes Butter Oil and its fractions.....	90
15.	CLSM micrographs of the butter oil and obtained fractions.....	92
16.	Fat crystal size distribution of both Buffaloes Butter Oil and obtained fractions.....	93
17.	Solid fat content (g/100 g)of modified butter spread (MBs).....	107
18.	Peroxide Value (PV) meq O ₂ /Kg fat.....	109
19.	Thiobarbituric acid value (malonaldehyde mg/Kg fat).....	111
20.	Radical scavenging activity (RSA%).....	114
21.	DSC melting curves of BF, CB and modified butter spreads.....	118
22.	Firmness (N/mm) modified butter spread (MBs).....	120
23.	Stickness (N/mm) modified butter spread (MBs).....	121
24.	Sensory evaluation test of BF, CB and modified butter spreads during cold storage at 5°C.....	125