

CONTENTS

	<i>Page</i>
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	6
2.1. Structural differences in algae	6
2.2. Composition of algae protein	7
2.2.1. Protein content	7
2.2.2. Amino acid composition of algae protein	9
2.2.3. Algae protein-pigment complex	11
2.3. Functional properties of algae protein	12
2.3.1. Emulsification properties	12
2.3.2. Foaming properties	14
2.3.3. Viscosity	15
2.3.4. Water-oil absorption capacity	16
2.3.5. Solubility	17
2.4. Nutritional quality of algae proteins	18
2.5. The use of algae proteins in human nutrition	20
3. MATERIALS AND METHODS	29
3.1. Materials	29
3.2. Methods	30
3.2.1. Functional properties of prepared algae protein isolate	34
3.2.2. Chemical analyses	36
3.2.3. Physical analyses	39
3.2.4. Rheological properties of yoghurt	41
3.2.5. Sensory evaluation of ice milk	42
3.2.6. Sensory evaluation of yoghurt	42
3.2.7. Statistical analysis	42
4. RESULTS AND DISCUSSION	43
4.1. Part I: Algae protein properties	43
4.1.1. Chemical composition and functional properties of algae protein isolate	43

	4.1.1.1. Gross composition of brown algae	43
	4.1.1.2. Mineral content of algae	45
	4.1.1.3. Amino acid composition of algae proteins isolates	45
	4.1.2. Functional properties	49
	4.1.2.1. Foam capacity and foam volume stability	49
	4.1.2.2. Foam volume stability (F.V.S%)	49
	4.1.2.3. Emulsifying properties	51
	4.1.2.4. Water and oil absorption capacities	59
	4.2. Part II: Effect of replacing non-fat dry milk with algae protein isolate on the quality of ice milk	63
	4.2.1. Ice milk mix properties	66
	4.2.2. Properties of resultant ice milk	71
	4.2.3. Properties of ice milk during the storage period	75
	4.3. Part III: Effect of replacing non-fat dry milk with algae protein isolate on the quality of flavoured yoghurt like products during refrigerated storage (6°C ± 1)	95
	4.3.1. Chemical properties	95
	4.3.2. Rheological analyses	114
	4.3.3. Amino acid contents	122
	4.3.4. Fiber and some mineral contents	124
	4.3.5. Organoleptic properties	126
5.	SUMMARY	131
6.	REFERENCES	144
	ARABIC SUMMARY	

LIST OF TABLES

No.		Page
(1)	Chemical composition (%) of crude dried algae and algae protein isolates (g / 100 g) dry weight.	44
(2)	Mineral content (mg / 100 g dry matter) of the dried crude brown algae and algae protein isolates.	46
(3)	Amino acid profile of algae protein isolate as compared with the WHO / FAO reference amino acid protein pattern (g amino acid /100 g algae protein isolate) (refrained from Becker, 2007).	47
(4)	Foaming capacity (%) of algae protein isolates preparation at different pH values.	50
(5)	Foam volume stability (F.V.S %) of algae protein isolates preparations.	52
(6)	The emulsifying properties of algae protein isolates preparations.	56
(7)	Water and oil absorption capacities of algae protein isolates preparations.	60
(8)	Formula of ice milk mixes made by substitution non-fat dry milk (NFDM) with different levels of algae protein isolates.	65
(9)	Effect of replacing non-fat dry milk with algae proteins isolates on ice milk mixes properties.	67
(10)	Properties of the resultant ice milk as affected by replacing non-fat dry milk with algae protein isolates.	72
(11)	Effect of replacing non-fat dry milk with algae protein isolates on total solids content of ice milk.	76
(12)	Effect of replacing non-fat dry milk with algae protein isolates on total protein content of ice milk.	78
(13)	Effect of replacing non-fat dry milk with algae protein isolates on fat content of ice milk.	79
(14)	Effect of replacing non-fat dry milk with algae protein isolates on ash content of ice milk.	81

(15)	Effect of replacing non-fat dry milk with algae protein isolates on titratable acidity of ice milk.	82
(16)	Effect of replacing non-fat dry milk with algae protein isolates on the pH value of ice milk.	84
(17)	Effect of replacing non-fat dry milk with 10% algae protein isolates on amino acids of ice milk.	86
(18)	Concentration of crude fibers (%) and some minerals (mg / 100 g) of ice milk “on dry weight basis”.	88
(19)	Effect of replacing non-fat dry milk with algae proteins isolates on the organoleptic properties of ice milk, when fresh and during storage up to 10 weeks at $-20^{\circ}\text{C} \pm 2$.	90
(20)	Statistical analysis of chemical composition of ice milk mixes.	91
(21)	Statistical analysis of ice milk properties.	93
(22)	Effect of replacing non-fat dry milk with algae protein isolates on titratable acidity (%) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	96
(23)	Effect of replacing non-fat dry milk with algae protein isolates on pH values of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	99
(24)	Effect of replacing non-fat dry milk with algae protein isolates on total solid content of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	102
(25)	Effect of replacing non-fat dry milk with algae protein isolates on the total protein content of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	104
(26)	Effect of replacing non-fat dry milk with algae protein isolates on the fat content of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	106

(27)	Effect of replacing non-fat dry milk with algae protein isolates on the ash content of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	107
(28)	Effect of replacing non-fat dry milk with algae protein isolates on the total volatile fatty acids (TVFA) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	109
(29)	Effect of replacing non-fat dry milk with algae protein isolates on acetaldehyde content ($\mu\text{g/ml}$) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	112
(30)	Effect of replacing non-fat dry milk with algae protein isolates on the curd tension (g) and viscosity (CP) of flavoured yoghurt like products treatments.	115
(31)	Effect of replacing non-fat dry milk with algae protein isolates on the whey syneresis (ml whey / 100 g) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$).	120
(32)	Effect of replacing non-fat dry milk with algae protein isolates on amino acids.	123
(33)	Concentration of crude fibers (%) and some minerals (mg / 100 g) of flavoured yoghurt “on dry weight basis”.	125
(34)	Organoleptic evaluation of yoghurt samples flavoured with strawberry (C_F) or guava (C_G) as affected by replacing non-fat dry milk with algae protein isolate during storage at $6 \pm 1^{\circ}\text{C}$.	127
(35)	Statistical analysis of yoghurt.	128

LIST OF FIGURES

No.		Page
(1)	Extraction of <i>Taonia atomaira</i> algal protein (Chronakis and Sanchez, 1998)	31
(2)	Foam volume stability (F.V.S %) of algae protein preparations. (Raw Algae protein isolates)	53
(3)	Foam volume stability (F.V.S %) of algae protein preparations. (Heated at 72°C for 30 sec.)	53
(4)	Foam volume stability (F.V.S %) of algae protein preparations. (Heated at 90°C for 15 sec.)	53
(5)	The emulsifying properties of algae protein preparations. (Raw Algae protein isolates at room temperature)	57
(6)	The emulsifying properties of algae protein preparations. (Heated at 72°C for 30 sec.)	57
(7)	The emulsifying properties of algae protein preparations. (Heated at 90°C for 15 sec.)	57
(8)	Water absorption capacities.	61
(9)	Effect of replacing non-fat dry milk with algae protein isolates of ice milk mixes properties viscosity and flow time.	69
(10)	Effect of replacing non-fat dry milk with algae protein isolates on pH value of ice milk.	85
(11)	Effect of replacing non-fat dry milk with algae protein isolates on titratable acidity of flavoured yoghurt like products treatments during refrigerated storage (6°C + 1).	97
(12)	Effect of replacing non-fat dry milk with algae protein isolates on pH values of flavoured yoghurt like products treatments during refrigerated storage (6°C + 1).	100
(13)	Effect of replacing non-fat dry milk with algae protein isolates on the total volatile fatty acids (TVFA) (ml NaOH 0.1 N/100 g) of flavoured yoghurt like products treatments during refrigerated storage (6°C + 1).	110

(14)	Effect of replacing non-fat dry milk with algae protein isolates on acetaldehyde content ($\mu\text{g} / \text{ml}$) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} + 1$).	113
(15)	Effect of replacing non-fat dry milk with algae protein isolates on the curd tension (g) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} + 1$) after manufacture of yoghurt.	116
(16)	Effect of replacing non-fat dry milk with algae protein isolates on the viscosity (CP) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} + 1$).	118
(17)	Effect of replacing non-fat dry milk with algae protein isolates on the whey syneresis (ml whey / 100 g) of flavoured yoghurt like products treatments during refrigerated storage ($6^{\circ}\text{C} \pm 1$	121

ABSTRACT

Title: Fortification of some dairy products with algae proteins.

By: Aisha Mohamed Metwaly El-Batawy

For: The Degree of Ph.D. in (Dairy Science and Technology).

Dairy industry is facing several problems in supplying consumers with specific functional dairy foods. These problems arose from shortage in milk proteins supply, high price of powdered milks and production of unique dairy products, that meet the need of both consumer and market. Incorporation of algae protein in some dairy products such as cheese fermented milk and ice milk will alter the physic-chemical properties of these products. Also, these treatments will enhance the health benefits of these products. Marin algae has long been used as food and medicine in Asian countries such as Japan, China and Korea. The protein in algae contains all essential amino acids (EAA) which available throughout the year, although seasonal variations in their concentrations are known to occur. Algal protein has many potential applications in new product and fortification and hence offers an exciting alter native protein source for use in various food products. Functional properties like foaming, viscosity and emulsification of this algal protein have the potential to find use in meat, ice cream bakery food, pharmacealicl and baby food formulations. The main objective of this study was to evaluate the possibility of replacing non-fat dry milk (NFDM) with algae protein isolates in the manufacture of ice milk and yoghurt.

This Thesis includes three parts under the following titles:

1. Study the chemical composition and functional properties of algal protein isolates extracted from brown algal.
2. Effect of substitution of non-fat dry milk (NFDM) with algal protein isolate on ice milk chemical composition and quality attributes.
3. Effect of substitution of non-fat dry milk (NFDM) with algal protein isolates on yoghurt chemical composition and quality attributes made from cow's milk.