Studies on the Use of Soy-Bean in Dairying

Thesis Submitted in Partial Fulfilment of the Requirements for the M. Sc. Degree

by

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A P P R O V A L S H E E T

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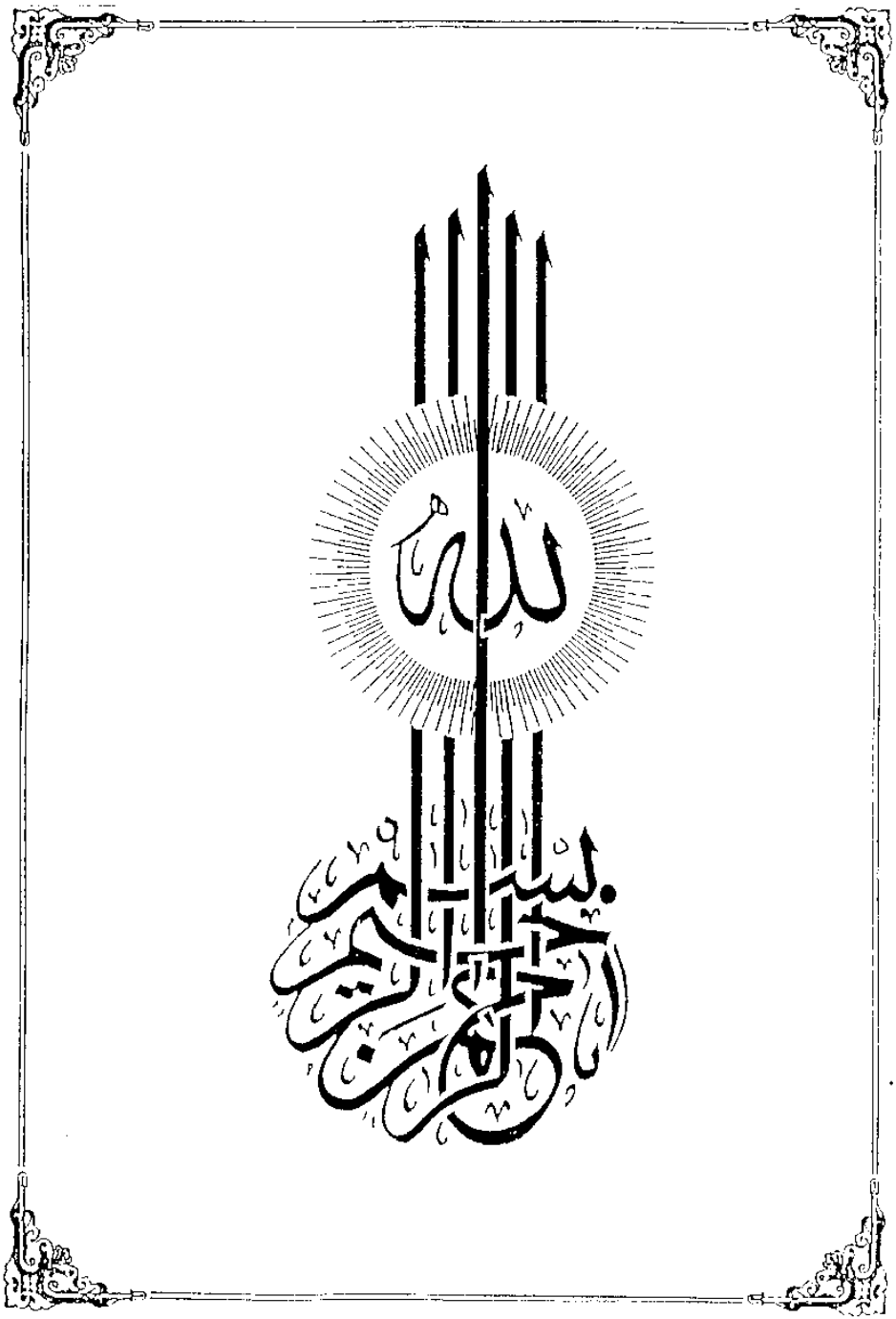

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C O N T E N T S

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I N T R O D U C T I O N

Similar to many other countries, native animal food ingredients in Egypt, e.g. meat, milk, egg are noticeably beyond the national demands. Some sort of substitutes for major food constituents in the mentioned foodstuffs should be seeked to face the remarkable rate of increase in population.

Among the known industrial uses, e.g. production celluloid, plastics, paints, glycerin, oil cloth, varnish, enamels, rubber ... etc., soybean was used earlier as a satisfactory resource for the manufacture of several foodstuffs e.g. margarine, flour, vegetable oil, soymilk ... etc.

Soymilk is the name given to soybean's aqueous extract or to the fine emulsion of soyflour. It characterised by its milky appearance and its considerably cheap source of protein for which reason it is recommended for feeding persons and infants with allergy or intolerance to cow's milk.

Briefly, soybean is an erect, bushy, leafy annual legume. It has been the most important legume in the development of civilisations of China, Manchuria, Korea and Japan. The first reference to soybeans being grown in

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U. S. A. appeared in 1804, but it was not until more than a hundred years later, that this crop assumed major agricultural importance. During the period of 1943 - 1952, an average of 11,559,000 acres of soybeans were grown annually in the United States. Of this amount, 81 % were grown for beans, 11.3 % were cut for hay or silage and the remainder was pastured or ploughed under for green manure. There are more than 2500 varieties of soybeans in U. S. A. but only 100 ones are grown commercially.

The production of soybeans has been remarkably increasing in the states from a crop of a certain commercial importance, to one of the greatest sources of vegetable protein. In Egypt some provisional satisfactory results were attained by the Department of Agriculture "Legume Research Section" who tried few varieties, e. g. Hampton, U. C. Hampton, Lee, and Robel.

With the foregoing in view, and as a result of the existing shortage in our dairy milk supplies it was thought of carrying out this study, to throw some light on :

1- The possibility of achieving the most ample

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extraction conditions to attain soymilk with the utmost acceptable properties and least cost.

2- The possibility of using the resultant is one of the popular dairy products, mainly ice cream.

Any achieved success might encourage making use of that substitute in other dairy and dairy like products.

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REVIEW OF LITERATURE

A) Identification and history

The soybean milk resembles cow's milk in appearance and contains proteins, carbohydrates and minerals which are extracted from ground raw soybeans with water (Woodruff, 1938). Von Loesecke (1942) described soybean milk that it is a white or creamy emulsion resembling cow's milk in appearance and consistency. Markley (1951) mentioned that soybean or vegetable milk is known to the Chinese as "bean curd sauce". You Winston et al. (1968a) recorded that the term soymilk is generally applied to the aqueous extract of soybeans, which is similar to cow's milk in appearance, however, they added that the flavour of the two products is quite different.

Piper et al. (1923) indicated that Whai Nain Pee, introduced soymilk to the people in China some years later. Bailey et al. (1935) reported that soybeans and products derived from them have played a major role for many centuries as a source of proteins in the diet of millions of people in Asia. According to Japan FAO. Assoc. (1958), soybean is an important food for Japanese people as a

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source of oil and protein. You Winston et al. (1968 a) indicated that the history of soymilk in China covers more than two millennia.

B) Nutritional value

Soybeans offer excellent possibilities as a source of a large quantity of high quality protein suitable for use in many ways as human food (Hafner, 1959). Desikachar et al. (1946) found that the biological values of cow's milk, soybean milk, and raw soybean were 82.8, 79.2, and 55.1 respectively. The corresponding values of their digestibility coefficients were 89.7, 90.9, and 82.8 in the same order. These results indicated that soybean milk possessed 90 to 95 per cent of the nutritive value of cow's milk. Change and Murray (1949) stated that growth and nitrogen balance experiments on rats showed that the proteins of soybean milk were about 80 %. Krober and Gibbons (1952) suggested that the good balance of amino acids in soybean protein makes it an excellent substituent of animal rations. Van Buren et al. (1964) reported that the value of soybeans as a food is due to their high content of protein. Dutra De Oliveira and Scatena (1967) studied the nutritional value of the protein of soybean milk and found that the

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growth response was generally less with soymilk. They added that this could be corrected by supplementation with methionine.

C) Methods of Preparation

Von Loesecke (1942) stated that the composition of soymilk varies greatly according to, the method of preparation, composition of the beans, amount of water used and degree of concentration to which the milk has been subjected. Markley (1951) reported that soybean milk is made in China from straw - yellow or yellowish green varieties of soybeans.

You Winston et al. (1968 a) gave the following classical Chinese method for producing soymilk. In brief, the soybeans are soaked in cold water until hydrated, ground finely with added water in a stone mill to form a slurry, filtered to remove the insoluble residue and finally soymilk is boiled to improve flavour. They found that the yield of soybean solids in the form of soymilk was about 65 % in this process. Smith and Beckel (1946) stated that soybean milk, as ordinarily produced, does not have either the bland flavour or smooth texture of cow's milk.

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Miller (1937) described a process in which he used whole variety soybeans and volatilized the "beany" flavour from milk by boiling the finely ground slurry and removed the solid residue by centrifugation. He added that in order to make a balanced milk, sugar, vegetable fat, and salt are added, this mixture is then boiled with agitation for 30 - 60 minutes under conditions which prevent coagulation of the protein on the surface of the milk. This boiling process is credited with improving the flavour of the milk, which is finely homogenized and bottled or spray dried.

Bluminthal (1947) explained another process for manufacturing soymilk in which the dried beans are soaked for few hours, then finely crushed and boiled for about 30 minutes in the proportion of 3 parts of water to 1 part of mash, a milky emulsion is obtained and this liquid separated out by means of a very fine seive or cloth strainer.

Hand et al. (1964) reported a method for preparing soymilk by dehulling and fine grinding of steam dried soybeans, then slurrying the powder with water to produce soymilk. You Winston et al. (1968 a) found that

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the previous process utilized 90 % of the soybean solids.

Mustakas and Mayberry (1964) developed another process for obtaining soymilk. Dehulled soybean flakes, which are properly conditioned with moisture, are fed into an orifice under conditions of high-temperature, short time and high pressure from which the bean mixture emerged cooked, puffed, and dried. The puffed material is then ground and slurried with water to form soymilk.

Steinkraus and Hackler (1966) reported that soymilk could be attained from dry soybeans by grinding them with boiling water.

Wilkens et al. (1967) produced an acceptable bland milk by grinding the dehulled beans (without previous soaking) with water at 80 - 100°C and holding at the grinding temperature for 10 min in order to destroy the lipoxidase enzyme.

You Winston et al. (1968 b) recorded that elimination of the hydration step which, at room temperature, resulted in many pre-germination enzymic changes, produced soymilk with much improved flavour.

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D) Effect of some processing treatments on soymilk properties

1- Soaking process

Yan (1927) reported that pre-soaking beans for 8 hrs resulted higher of bean solids in the milk than using either non soaked or beans soaked for shorter periods. You Winston et al. (1968 b) stated that the soaking process did not only facilitate grinding but enabled also better dispersion and suspension of bean solids during extraction. They found that soybean soaked for 8 hrs before extraction yielded higher milk solids than unsoaked beans or bean flour in spite of a loss amounting 1.6 % solids in the soaking water. You Winston (1968 a) also mentioned that if the soaking time of soybeans increased, larger quantities of water soluble solids would leach into the soaking water. To minimise losses in soaking water they suggested a soaking period enough to double the initial dry weight of the beans. Again You Winston et al. (1968 b) recorded that the pre-soaking of the beans yielded a higher average volume of soymilk than either unsoaked beans or bean flour, even though additional water was added to the non-soaked beans to compensate for the water

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taken up during pre-soaking. They added that soymilk prepated from pre-soaked beans showed higher pH value than milk prepared from bean flour or non-soaked beans.

2- Extraction temperature

Using extraction temperatures ranging from 20 to 90°C, Beckel et al. (1946) found that temperatures between 70 to 75°C gave the highest yield of proteins from defatted soybean meal, they used filteration process for separating the insoluble residue. Tan (1958) reported that no variation in the yield of solids when soybeans were extracted at different temperatures between 20 and 50°C by using centrifugation method for separation of the insoluble solids. Wilkens et al. (1967) stated that the maximum soymilk solids was obtained when they used an extraction temperature of 60°C. You Winston et al(1968b)found that extraction temperature between 55 and 65°C gave highest yields of the solids in the milk, regardless the soaking treatments. They added that additional difficulties were encountered by filtering the soymilks when soybeans were ground at temperature above 85°C which resulted a decrease in the volumes of soymilks produced. Generally they observed a gradual rise in the pH of soymilk when

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temperature of extraction was increased from 30 to 95°C.

3- Heat treatment

Krishnamurthy et al. (1958) stated that heat processing of milk improved the nutritive value of the soybean protein as a result of destruction of the trypsin inhibitor. Tan (1958) investigated the effect of both pasteurization and sterilization on soymilk. He found that soymilk could be stored for three days with no substantial spoilage when it was pasteurized for 30 minutes at 60°C. Sterilization for five minutes at 120°C was found to be quite adequate for one year storage without spoilage. He added that overheating the soymilk would result a dark colour and pronounced cooked flavour.

Iriarte and Barnes (1960) found that the only factors which contribute to the decreased nutritive value of the protein of excessively heated soybeans were, destruction of cystine and decreased in nitrogen absorbability. Hackler et al. (1965) indicated that the protein efficiency ratio of soymilk heat processing was dependent upon both time and temperature of treatment. They added that there was no adverse effect on protein efficiency

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