Market Survey of Solid Fats Used in China

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INTRODUCTION

Ever since the successful economic reform and implementation of open market policy in China, the food industry has developed tremendously into a sophisticated speciality fats market. Solid fats such as dough fat, margarine, shortening, palm stearin and animal fats have emerged as important ingredients in the food processing industry. Margarine processing technology was introduced into China in the early 1980s and by 1984, the manufacturing capacity of margarine and shortening recorded was about 20 000 t yr^{-1}. The built up capacity reached 150 000 t in 1996, and increased further to 300 000 t in 2001. The oils and fats industry went through changes after China gained WTO accession in late 2001. Foreign-funded enterprises entered China increasing the capacity of margarine, dough fat and shortening production and it has reached 1 million tonnes per year.

In China, climatic variations may affect solid fat applications. China being a big country can be divided into six climatic zones *i.e.* cold temperate, mid-temperate, warm temperate, subtropical and tropical zone, and highland plateau zone. These varied climatic conditions require solid fats in different regions to meet their specific applications.

The objective of this survey was to identify various types of solid fats used in China food industry and to analyse the market pattern of hydrogenated oils used in China's food manufacturing industry and to promote technology and uses of palm oil as a replacer of hydrogenated oils and animal fats in the conventional solid fats market to reduce or avoid *trans* fatty acid formation.

TRANS FATTY ACIDS (TFA)

Solid fats commonly made from animal fats or hydrogenated oils *e.g.* lard, tallow and hydrogenated hard fats, contain undesirable cholesterol and *trans* fatty acids (TFA). Besides the added cost of partial hydrogenation of polyunsaturated vegetables oils to yield the right consistency for solid fat manufacturing, TFA is formed during partial hydrogenation. *Trans* fat consumption is linked to increasing cholesterol and coronary heart disease.

Cholesterol content in fats vary. In general, main sources of dietary cholesterol are from animal sources (*e.g.* meat, poultry, fish and dairy products), while foods of plant origin contain no cholesterol. The cholesterol contents of oils and fats are shown in *Table 1*. Although cholesterol is required for the normal function of cells in the human body, high levels of cholesterol in the blood increase the risk of coronary heart disease.

Long term intake of *trans* fatty acids can raise LDL cholesterol (the bad cholesterol) levels in blood, and lower HDL (the good cholesterol) levels. Dietary oils and fats should have a balanced fatty acid composition and should con-

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tain no/negligible *trans* fatty acids (TFA) levels. These nutritional facts of oils and fats are receiving increasing attention from consumers and health authorities. Relevant authorities have recommended reducing the consumption of *trans* fats and cholesterol. After decades of research studies, the World Health Organisation (WHO) recommends that the dietary intake of *trans* fatty acid should be kept as low as possible. In 2003, Denmark was the first country to set a limit for *trans* fat in food of not more than 2%; Canada, Switzerland and the United States followed with stringent labelling law requirements for *trans* fat content in food. More recently, Norway imposed a ban on hydrogenated fat in food ingredients. Brazil, requires labelling of food containing *trans* fatty acid levels of more than 0.5%. By January 2013, China will impose a labelling law which stipulates the labelling of *trans* fat in food nutrition labels.

SOLID FATS CONSUMPTION IN CHINA

China margarine production pattern as compared to the world is shown in *Table 2*. From 2005 to 2010, the worlds margarine production hovered at 10 million tonnes. During the same period, margarine production in China increased from 167 000 t to 260 000 t, experiencing an annual increase of 10%.

Since there is no export or import of margarine recorded in the above, it is assumed that all the margarine produced was consumed domestically. The margarine consumption per capita in China is only 0.19 kg compared with the world average at 1.41 kg per capita (*Table 3*). There is a huge potential for the Chinese food industry to develop in this area. It is projected that China can have about seven times the existing production capacity for margarine to fulfil the demand of this market and to catch up with the world average standard.

There are a number of manufacturers already producing solid fats in China. These manufacturers are mostly private companies, state owned enterprises, joint ventures or foreign investments. The total production capacity of solid fats was about 1 million tonnes in 2010. The rest of the solid fats have to be imported to meet domestic demand. With the rapid expansion of China's food industry and changing eating habits in a more affluent society, the demand of solid fats is expected to increase tremendously in the very near future.

MATERIALS AND METHODS

Materials

Margarine, shortening, butter oil substitute and other products were collected from domestic market and food industry. The stan-

TABLE 1. OILS AND FATS CHOLESTEROL CONTENT

Types of oils and fats	Cholesterol (mg g^{-1})
Palm oil	nil
Soyabean oil	nil
Rapeseed oil	nil
Lard	3.5
Tallow	3.15

Source: MPOB (2009).

TABLE 2. THE WORLD AND CHINA MARGARINE PRODUCTION PATTERN (*1000 t)

Year	2005	2006	2007	2008	2009	2010
World	9542	10 042	10 048	9910	9797	9723
China	167	176	192	210	235	260

Source: *Oil World*.

TABLE 3. CONSUMPTION OF MARGARINE IN 2010

Category	World	China
Population (million)	6 909	1 331
Margarine consumption (*1000 t)	9 723	260
Average consumption of margarine kg/capita	1.41	0.19

Source: *Oil World*.

dard reference materials, such as fatty acid methyl esters of C16:0, C17:0, C18:0, C18:1c-9, C18:1t-9 were acquired to calibrate the GC for TFA analysis.

Methods

Slip melting point - Slip melting point (SMP) was determined using MPOB Test Method, p 4.2 (MPOB, 2005).

Solid fat content - Solid fat content (SFC) was determined by nuclear magnetic resonance (NMR) using Oxford Instrument (MQC), using MPOB Test Method, p 4.9 (MPOB, 2005).

Trans *fatty acid composition* - *Trans* fatty acid composition (TFAC) was determined by Agilent 6890 Gas Chromatography using MPOB Test Method, p 3.5 (MPOB, 2005).

Iodine value - Iodine value (IV) was determined using to MPOB Test Method, p 3.2 (MPOB, 2005).

RESULTS AND DISCUSSION

For the purpose of this analysis, commercial samples of solid fats used in China namely margarine, shortening, butter oil substitute and others were collected from the domestic market and food industry to study consumption and application patterns. These samples can be classified into northern and southern regions of China. Samples collected from the northern region includes Beijing, Shanghai, Tianjin, Henan, Jiangsu, and Zhejiang province; and samples collected from the southern region is from Guangdong province (*Table 4*).

Summary of SFC, SMP and IV of margarine, butter oil substitute, shortening and others were shown in *Table 5*. The distinct differences between the climates of China's southern and northern region determine the use of various types of solid fats. The northern region is in the cold temperate zone, where winter temperatures can fall below 0°. Therefore, the solid fat products in this market do not need extensive hydrogenation to obtain a hard consistency.

The SMP of a product indicates the hardness and mouth-feel of the product. It also indicates the temperature at which the solid fat product begins to melt.

The SMP of margarine in the northern region was found to be in the range of 33℃-45℃, with an average of 38.4℃, and in general, it is lower than that of the southern region. In comparison, the SMP of margarine in the southern region is found to be in the range of 40℃-52℃, with an average of 42.4℃.

The SFC Profile of a product indicates the quality characteristics of the mouth-feel of a product, such as sandiness, smoothness and cooling sensation. It also indicates the ease of application in the food processing process.

SFC of margarine from the northern region was also found to be lower than that of the southern region which is shown in *Figures 1* and *2*; the same pattern is observed for shortening and butter oil substitute. *Figure 3* shows the SFC comparison of margarine, shortening and butter oil substitute. This also indicates that the different fractions of palm oil can be used to replace these solid fats to satisfy the various specific requirements.

The IV of oils and fats indicated the identity of the types of oils and fats. The degree of hydrogenation is also measured by IV. In order to

TABLE 4. SAMPLES DISTRIBUTION

Type	Quantity of samples (n)		
	Total	Northern region of China	Southern region of China
Margarine	19	13	6
Butter oil substitute*	9	5	4
Shortening	11	7	4
Others**	8		

Note: Butter oil substitute*: blend of butter flavour with hydrogenated vegetable oil or animal fats.
Others**: animal fats, emulsified fats and fats specialised for frozen food.

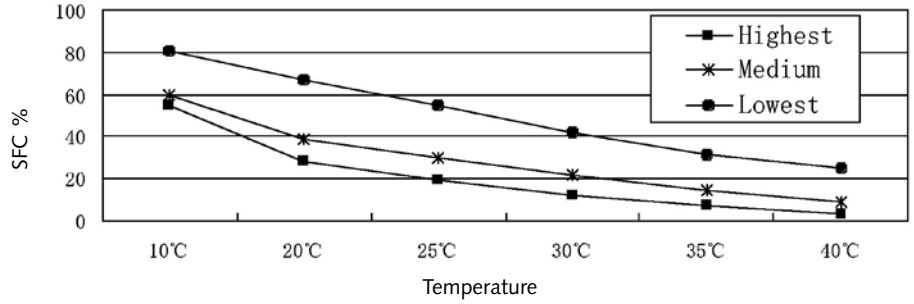

Figure 1. Solid Fat Content (SFC) of margarine in southern region between highest, medium and lowest.

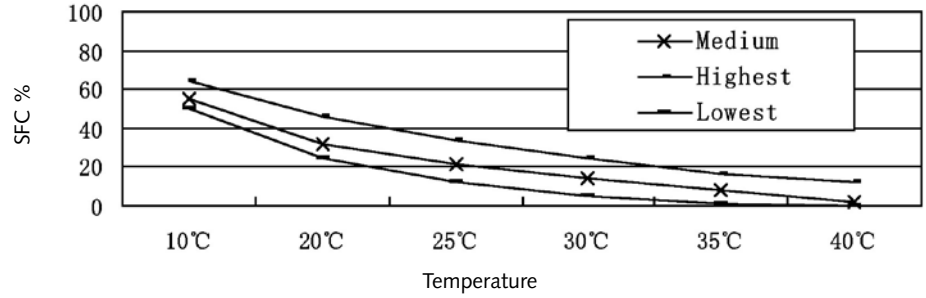

Figure 2. Solid Fat Content (SFC) of margarine in northern region between highest, medium and lowest.

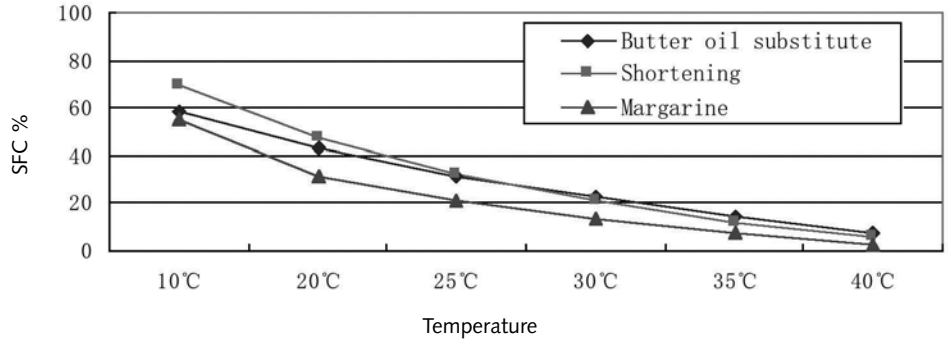

Figure 3. Solid Fat Content (SFC) comparison for margarine, shortening and butter oil substitute.

TABLE 5. ANALYSIS OF SFC, MP AND IV

Name of product	10°C	20°C	25°C	30°C	35°C	40°C	MP°C, Average MP°C	IV gI_2/100 g Average IV
Margarine (north) n=13	43-67	23-46	13-30	5-20	0.9-13	0-7	33-45 38.4	38-70 51.54
Margarine (south) n=6	50-80	28-66	19-55	12-42	7-31	3-25	40-52 42.4	46-66 53.87
Butter oil substitute (north) n=5	35-59	14-44	7-31	3-23	0.9-15	0.2-9	33-44 37.5	49-65 57.44
Butter oil substitute (south) n=4	51-60	27-38	22-27	12-19	7-13	3-7	39-42 40.7	48-62 51.53
Shortening (north) n=7	61-81	36-65	23-52	15-40	9-29	0.3-21	39-54 41.2	38-56 48.18
Shortening (south) n=4	63-82	40-67	26-56	17-43	10-32	6-25	41-52 46.03	35-46 43.04
Other products n=8	31-61	3-43	0-33	0-25	0-17	0-10	20-46	47-69

modify the consistency of fats, hydrogenation process is employed. This hydrogenation process will add cost to the manufacturers and the partial hydrogenation will produce undesirable *trans* fatty acids.

Solid fats are usually formulated by blends of oils which are sourced from animal fats, hydrogenated oil and palm oil. Products that require good spread-ability properties (*e.g.* soft consistency), less solid fats ingredients may be used to reduce the cost of production as hydrogenation process will increase the cost accordingly.

The other samples collected in this survey *e.g.* animal fats, emulsified fats and fats for frozen food, were analysed and identified as tallow, lard and palm oil. These products are natural products and disguised as emulsified fat. Fats specifically designed for frozen food do not undergo further processing and therefore retain their identity and are easily identified.

The objective of this project is to use healthy palm oil to substitute animal fats and maintain the desired characteristics of prolonging the shelf life of finished products, and avoiding undesirable cholesterol and *trans* fat in food. Standard characteristics of healthy palm oil in comparison with tallow and lard are as follows (*Table 6*). This is to assist in identifying the ingredients and formulations of those finished products in the market.

As represented by the survey, only 23% of the solid fats sampled contained no *trans* fatty acid. Seventy-seven percent contained certain levels of *trans* fatty acid, of which 39% had undergone hydrogenation resulting in undesired *trans* fat in the finished product (*Table 7*). These solid fat samples were also analysed for TFA levels (*Table 8*). Considering the recommendations for dietary *trans* fatty acid, solid fats should contain less than 2% *trans* fatty acid. Therefore, palm oil can be used readily to replace these solid fats at a competitive cost.

CONCLUSION

This market survey confirmed that in China 77% of solid fats in the market contain various levels of *trans* fatty acids. Of which, 39% contain more than 2% *trans* fatty acid and have undergone some kind of hydrogenation. The survey also confirmed that only 61% of the solid fats sampled met the labelling requirements in Europe. Palm oil has the potential to replace all these solid fats to reduce the *trans* fatty acid levels in China's solid fats products. Additionally, present technologies are available to replace cholesterol containing animal fats with palm oil, the healthier option.

TABLE 6. STANDARD CHARACTERISTICS OF PALM OIL AND ANIMAL FAT (TALLOW AND LARD)

Characteristics	IV gI_2/100 g	SMP °C	SFC					
			10°C	20°C	25°C	30°C	35°C	40°C
Palm oil range	50.4-53.7	33.8-39.2	46.1-53.7	21.6-26.1	12.1-16.3	6.1-10.5	3.5-7.9	0-4.6
Tallow	34-47	40-46						
Lard	46-70	20-52						

TABLE 7. RESULT OF SURVEY

Solid fats containing TFA	% of products
Without TFA	23
With TFA	77
With TFA (not more than 2%)	38
With TFA (more than 2%)	39

TABLE 8. TFA ANALYSIS

Type	Region	Number (n)	TFA		No *trans*		0%-2% TFA		2%-10% TFA		>10% TFA	
			Number (n)	%	Number (n)	%	Number (n)	%	Number (n)	%	Number (n)	%
Margarine	North	13	12	92	1	8	7	54	3	23	2	15
	South	6	4	67	2	33	1	17	3	50	0	0
	Total	19	16	84	3	16	8	42	6	32	2	10
Butter oil substitute	North	5	5	100	0	0	2	40	2	40	1	20
	South	4	4	100	0	0	3	75	1	25	0	0
	Total	9	9	100	0	0	5	56	3	33	1	11
Shortening	North	7	3	42	4	58	1	14	1	14	1	14
	South	4	2	50	2	50	2	50	0	0	0	0
	Total	11	5	45	6	55	3	27	1	9	1	9
Others		8	6	75	2	25	2	25	4	50	0	0
Total: Solid fats		47	36	77	11	23	18	38	14	30	4	9

REFERENCES

DE GREYT, W; GIBON, V; MAES, J and KEIIENS, M (2010). Developments in edible oil modification for the production of *trans*-free food fats. *Oil Palm Bulletin, No. 61*: 38-44.

MENSICK, R P and KATAN, M B (1990). Effect of diety *trans* fatty acid on high density and low density lipoprotein cholesterol levels in health subjects. *New Engl. J. Med.*

MOHD SURIA AFFANDI YUSOFF; MAIMUNAL SANNY and KARIMAH AHMAD (1995). Palm-based imitation cheese. *Palm Oil Developments No. 23*.

MPOB (2005). *MPOB Test Method.* MPOB, Bangi, Selangor.

ROSIDAH RADZIAN; TANG THIN SUE; OOI CHENG KEAT and WONG SOO KHWAN (2009). *Palm Oil Pocketbook of Palm Oil Uses*. Six edition. MPOB, Bangi, Selangor.

SIVARUBY KANAGARATNAM; MISKANDAR MAT SAHRI; NOR AINI IDRIS; THIAGARAJAN TARGAVELU and MOHD JAAFFAR AHMAD (2008). Palm-based *trans*-free roll-in margarine. *Palm Oil Developments No. 48.*

STEEN STENDER; JORN DRERBERG and ARNE ASTRUP (2006). Consumer protection through a legislative ban on industrially produced *trans* fatty acids in food in Denmark. *Scandinavian Journal of Food and Nutrition; 50 (4)*: 155-160.

WAN ROSNANI WAN ISA and NOOR LIDA HABI MAT DIAN (2008). Palm-based *trans*-free whipped topping as an alternative to dairy cream. *Palm Oil Developments No. 48.*