# The Ghee Problem in India.

THE Ghee Problem in India was the subject of a symposium held under the joint auspices of the South Indian Sciences Association, Bangalore, Society of Biological Indian Chemists (India) and the Madras Branch of the Indian Chemical Society, at Bangalore on the 16th April. The following papers were contributed :—

MR. B. N. BANERJI : "*The Metabolism of Fat.*"—From the physiological point of view, ghee is a mixture of true fat, *i.e.*, glycerides of fatty acids, lipoids like lecithin and cephalin containing nitrogen and phosphorus in combination, and the unsaponifiable sterols. In the animals two types of fats are distinguished—the tissue fat and the reserve fat. The former is uniform in composition while the latter depends on the diet. Fats from different parts of the body differ considerably in composition and consistency. Tissue fats are more unsaturated than reserve fats. The fats function an important rôle in metabolism. They yield the highest caloric energy and their ability to be stored up in large quantities makes them a convenient form of reserve food for the organism. They serve also as good insulators against temperature changes. Fats are an essential item of food and carriers of vitamins and other growth-promoting factors. Growth cannot be obtained on an entirely fat-free diet. Fat is digested in the intestines after emulsification by the pancreatic lipase. Most of the fatty acids are converted into soaps which are absorbed in the mucosa. They then pass into blood through the lymphatics. One to three hours after food the blood fat rises reaching its maximum in 6 to 7 hours after which it returns to normal. The oxidation and disposal of blood fat is obscure. The liver where desaturation takes place is the most important organ in fat metabolism. Apparently, all fats can be synthesised in the body, and proteins and carbohydrates can produce fat. But whether all the fatty acids can be synthesised is not known. Addition of linoleic acid to fat-free diet cures deficiency but not the addition of saturated acids. Linoleic acid therefore is not synthesised in the body. Fat excretion is fairly constant 5 to 10% being absorbed ; there is no fat in urine, very little in sweat and the greater portion is excreted in the fæces. Age, sex, heredity, disturbance of endocrine glands, gonads and pituitary, alter the deposit of the fat pattern. However, there is no disturbance of fat metabolism in obesity. The factors that cause disturbance in blood fat are very meagrely understood. Blood is apparently a system for transportation, and many confusing notions are extant. The real metabolism of fat, the lipoids and sterols is not fully known, though their importance as an essential item in cell function and transportation is undeniable.

Lipoids are definite constituents of protoplasm. They act as carriers of fats in utilization by the cells. Lipoids are synthesised in the body from inorganic phosphorus. The sterols, cholesterol of animals and phytosterol of plants, are also important constituents of all protoplasm. Their importace in cell membrane functions and as carriers of vitamins are well known.

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MR. N. C. DATTA : "*The Dietetic Value of Ghee.*"—The adulteration of milk products like ghee and butter is of recent origin in India. The introduction of vegetable ghee has made the problem of getting pure ghee rather difficult. Enormous quantities of vegetable ghee manufactured in India and also imported from other countries are used for adulteration purposes. Owing to lack of proper euforcement of the Foods and Drugs Adulteration Act, the adulterated ghee trade is flourishing very well. From the dietetic point of view, as a glyceride of fatty acids, in calorific value, vegetable ghee is equivalent to pure ghee but in contrast to other fats, pure ghee has certain peculiar properties, namely, low melting point and high emulsifying power. Many vegetable ghees are not so easily emulsified and melt at a temperature much higher than the body temperature, so that their use can be held objectionable on the contention that they will be less digestible than pure ghee. Ghee prepared by melting pure butter contains vitamin A and is found to be quite as good as pure butter, whereas the hydrogenated oils contain little or no accessory food factor so that vegetable ghee has not as good a nutritive value as pure ghee. Pure ghee and vegetable ghee sell almost at the same price in many parts of India so that the use of vegetable ghee does not hold good even on economical grounds.

In cities like Madras, Calcutta, Bombay, where milk and vegetables containing vitamin A are expensive, the poor and the middle class people are subsisting on the border of their vitamin A requirements. According to Sir McCarrison the diet of the people of Madras and Bengal are usually poor in vitamin A, so that the use of vegetable ghee will certainly affect the health of the people. Particular classes in certain cities, a few families everywhere and numerous individuals throughout the country suffer from a deficiency of vitamin A through the neglect of the use of milk, butter and ghee. The high rate of mortality, the ill-health of young mothers and incidence of diseases like tuberculosis clearly indicate the want of proper nutrition among the people of India. It is highly desirable from the physiological point of view that greater consumption of milk in the country should be encouraged.

India is essentially an agricultural country whose fertile soil and climatic conditions, particularly favourable for the growth of grass, make dairying a household industry well adapted for the country. Proper education among the farmers, and the use of plenty of green grass and sunshine enriching the milk with more of vitamins A and D, will offer the greatest promise to further development of Dairying in India.

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MR. Y. V. SRIKANTESWARA IYER : "*Adulteration and Analysis of Ghee.*"—It is to be deplored that in India there are no satisfactory standards of supply of food materials. Most of the countries abroad have laws in accordance with which the sale of impure or adulterated foods is made a criminal offence and many are provided with public Analysts and other officers to enforce these laws and punish the offenders. The importance of legal control of such commonly used articles of food as milk, butter, ghee and various kinds of edible oils, etc., cannot be over-emphasized. So far, their manufacture and sale have not been legalized

in our country and it has afforded great opportunity for the growth of fraudulent trade.

The practice of adulterating food materials is comparatively of recent origin in India. There are two kinds of adulteration in practice. The scientific manner practised mostly in the Western countries and the non-scientific one that is generally prevalent in India. The non-scientific adulteration is easily detectable and therefore an efficient check, if exercised over the sale of the food materials, would completely efface this vicious practice. With the advent of the oil hardening industry and the establishment of factories for the purpose in some parts of India, there has been a great stimulus given to this kind of adulteration in oil trade which has been responsible in baffling the Analysts engaged in detecting these adulterations.

With respect to ghee, which is nothing but pure milk fat, the problem of adulteration is of great concern to our nation. The detection of adulteration of ghee has been the subject of many investigators. The common adulterants that one comes across in India are some of the local edible oils like groundnut, sesame, cotton seed and the cocoanut, which are capable of being easily detectable by ordinary physical tests alone. But with the introduction of the refining, bleaching, de-odouring, hardening and flavouring methods for oils, one finds these adulterants incorporated in such a scientific manner that it has complicated the problem of their detection to a very marked degree. In addition to these local adulterants, "lard" of different grades is well incorporated with butter fat or at times is itself flavoured with artificial butter aroma and sold under the name of pure butter fat. It is, however, well known that it is only pure milk fat that contains fatty acids of a soluble and volatile nature in considerable quantity that possess the property of easy emulsification and digestion in the human system. All other fats fail markedly in this respect. Perhaps it was on account of this feature of milk fat that the superiority of the use of butter was recognized in India. The various substitutes like oleomargarine, margarine, butterine, commonly used in the West and other similar products but containing lard, etc., while supplying the required heat units to the body do not do so with so much of ease and benefit as butter fat. Besides, instances have not been wanting to show that these products have had very baneful effects regarding the digestion on those that consumed them.

The analysis of oils and fats being the most difficult branch of analytical chemistry, the analyst is faced with innumerable difficulties in the absence of specific standards. The Western standards that are in vogue, in many instances, are wholly inapplicable to Indian products. Therefore, the necessity for the establishment of standards based on the results of a thorough investigation is keenly felt by many workers. Unless the Government and the well-established scientific institutions take up this piece of work, it is impossible to expect a better future for the supply of pure food materials on which only depends the health of our nation.

The methods commonly adopted for the analysis of ghee are mostly empirical. With a careful handling and strict adherence to the technique of the methods one could arrive with difficulty at the purity or otherwise of the sample in question. The chief factors that throw light on the purity or otherwise of the sample of ghee are refractive index at 40°C (42 to 44), saponification value (230 to 240), iodine value (30 to 35). R. M. value (20 to 30) and soluble fatty acids (3.5 to 4). The origin of the fat can fairly be established by performing the well-known "Phytosterol Acetate test" where the melting point of the substance determines whether it is one of animal or vegetable or a mixture. The usual value of the melting point obtained for the "Cholesterol" Acetate is 113·5°C to 114·5°C showing animal origin and for the Phytosterol Acetate, 127°C and 133°C showing vegetable origin. There are other colour tests, too, which are resorted to at times and which prove very helpful.

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MR. P. RAMASWAMI AYYAR: *"The Chemical Aspect of the Ghee Problem in India."*—From the Chemical standpoint "Ghee" is rather a vague term. It may be the milkfat of the cow or the buffalo, or, in rare cases, that of other animals like goat, sheep, camel, etc. These milkfats differ markedly in their properties; for example, at the ordinary temperature of 25°C, goat's ghee is a liquid, cow's ghee is semi-solid, and buffalo-ghee quite solid. These differences are due to the varying chemical compositions of these fats; thus, goat's ghee consists of a large proportion (above 10%) of the easily digested glycerides of the lower fatty acids, butyric, caproic, caprylic and capric and only a small proportion of the difficultly digested high-melting glycerides of palmitic, stearic and arachidic acids; whereas buffalo-ghee contains under 5% of the lower glycerides and over 50 per cent. of the high-melting glycerides; while the composition of cow's ghee is intermediate in character. Most of the common edible fatty oils, like gingelly, groundnut, mustard and safflower oils do not contain any lower glycerides but are chiefly composed of the liquid glycerides, oleic and linolic acids with varying proportions of the high-melting glycerides of palmitic, stearic and arachidic acids; the only exception being cocoanut oil which contains up to 20 per cent. of the lower glycerides. The value of cow's ghee as an article of diet of the Indian intelligentsia is a matter of experience; and in the absence of definite knowledge of the exact manner in which the various glycerides of cow's ghee are utilized by the human organism for its metabolic and energy requirements, it will be unsafe to put on the market, any synthetic fatty product resembling ghee, as ghee substitute, without chemically ensuring that it contains all the glycerides present in cow's ghee.

Most of the ghee-substitutes on the market are, unfortunately, made from hydrogenated groundnut oil or similar products. Actually hydrogenation destroys the liquid linolic glyceride converting it into that of a solid isoleic acid which is more difficultly digested and more prone to rancidity than oleic acid; further, much of the liquid oleic glyceride is converted into the high-melting stearic glyceride, producing, on the whole, a ghee-like fat but entirely lacking in lower glycerides and in linolic acid. These chemical deficiencies in ghee-substitutes may lead to serious deficiency diseases as has recently been demonstrated in the case of rats by the work of the Burrs during 1929 to 1932 (*J. Biol. Chem.*, Vol. 82, 86 and 97). Any ghee-substitute should, therefore, contain the essential components of cow's ghee along with

appreciable amounts of linolic glyceride. It is also advisable to ensure absence of all iso-oleic glycerides. Any oil-chemist can easily manage the production of such a ghee-substitute.

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DR. R. BHATTACHARJEE: "*Ghee Substitutes, their Manufacture and Trade.*"—The manufacture of artificial ghee has called for a large amount of research. Started as a war measure, margarine has taken a good place as butter substitute in Europe. In a poor country like India, where increase of population has led to encroachment on grazing lands, the price of a dairy product like ghee is very high and beyond the means of many. In towns it is very difficult to get unadulterated ghee, and most of the products are grossly adulterated with vegetable and animal fats that are positively harmful as food. It is always better to consume a standard, pure and refined substitute than a product adulterated with unknown and undesirable constituents mixed up by ignorant and unscrupulous traders. As such the production of a good substitute, artificially made, is an important problem. The manufacture of artificial ghee requires four distinct operations, namely, the preparation of the base, refining and de-odourising, hydrogenation and blending or developing the ghee odour. The preparation of the base necessitates a very careful mixing of the edible oils, like cocoanut, groundnut, sesame, etc., to make up the constituents as near to that of ghee as possible and great ingenuity is called for in the preparation of such a base. Well tried edible oils can be safely used in the preparation of the base. Oil chemists and technologists are busy in the making up of such a base. The process of refining and de-odourising has necessitated a high standard of technological operation. The product has to be made water white in colour absolutely odourless, and this requires the use of the best grade of oils. Again the acidity has to be brought down to as low a figure as 0·02 % for hydrogenation. Naturally in hydrogenated fat we have one of the best refined fats possible. The process of hydrogenation gives us a product that is equal to the best samples of ghee in appearance and consistency. After hydrogenation the product has the same psychological value as any ghee on the consumer and his digestion. Finally, blending of the ghee odour requires the highest skill. Harmless odours are added, or the odour is developed biologically and then blended in the finished product with some suitable base. It cannot be said that the problem is solved because there are still a number of points to be tackled. There are four big factories in India that produce hydrogenated oils and besides a large amount of artificial ghee is imported from Holland which is the pioneer in this line. Time alone will determine the value of these substitutes on the health and future of the race. Digestibility and the question of vitamins A and D content have to be borne in mind. The researches of Windaus, Steenbock and Drummond have solved the question of vitamin D and it is hoped that the presence of vitamin A also will be ensured at an early date.

K. S. VARADACHAR.

## Science News.

*Chemical and X-ray Studies in Tertiary Coals.*—DR. C. MAHADEVAN, Assistant Superintendent, Hyderabad Geological Survey, writes that chemical and X-ray investigations were carried out with tertiary coals of the same geological age and horizon ranging from peaty lignites to anthracites. Chemical analyses of the coals indicate that in coalification, the degradation of the cellulose of the vegetable matter is at first rapid and the lignin is more resistant, in conformity with the generally accepted views; but after a certain stage, the destruction of cellulose seems to proceed at a much slower pace while that of lignin is more rapid. The presence of small amounts of cellulose in coals (as represented by Makerwal and Mach specimens) is an interesting result in this study.

Lignins were isolated from the coals by digestion with alkali and purified. The X-ray pattern of all these lignins are practically identical and resemble the pattern for flax lignin. On a comparison of the X-ray patterns for the untreated flax and its lignin, it is seen that except for the observation of fibrous nature in the untreated flax the halos in the two cases show great similarity.

In the case of lignite from Palana, the end residual products after alkali autoclaving and acid treatment give X-ray patterns very similar to the 'gamma compound' pattern of coals.

The X-ray patterns obtained with the peaty lignites and lignitic coals in the untreated state consist of two halos, one intense and the other somewhat fainter, the corresponding spacings for the two groups being 3.59 Å.U. (intense), 2.43 Å.U. (faint) and 3.5 Å.U. (intense) and 2.23 Å.U. (faint) respectively. The anthracitic coals give quite a different pattern showing unmistakable indications of free carbon in fairly coarse state. The spacing for the tertiary coals, *viz.*, 3.5 Å.U., are distinctly different from the corresponding values, *viz.*, 3·39 Å.U., for permocarboniferous coals, in spite of apparent similarity of the composition as determined by "proximate analysis". These observations are discussed in relation to the geological history of the coal fields from where the specimens were obtained and in relation to the Bergius' theory of coal formation in nature.

It is seen that in conformity with the field observations, the X-ray patterns show progressive alteration to anthracitic stage with increasing pressure. The Palana lignites which have not been subjected to much pressure show larger spacings for the halo similar to a pattern for peat; the next set of coals,—Mach and Makerwal—have been subjected to moderate pressure and they correspond closely to the normal tertiary coals studied from other horizons. The anthracitic coals which are from a region of great tectonic activity give patterns characteristic of free carbon and mineral matter.

The distinct difference between the X-ray patterns of the tertiary and the upper palæozoic coals, especially the higher spacings for the former in spite of their similar "proximate composition"