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and (9) More information about air currents and spore dispersal. The methods of collection of these data should be left to the meteorologist himself. The analysis of these data is a problem involving deep analytical and higher mathematical treatment.

UTILISATION OF DAIRY WASTES.*

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The subject of this paper relates to the utilisation of the waste products of the dairy and is based mainly on certain experiments conducted in 1918 with the object of investigating the possibility of manufacturing locally, food and other products which could replace similar products which used to be then and still to a large extent are imported from outside, but which war conditions had rendered very difficult to obtain.

When milk coming into the dairy could be all disposed of as milk there will be of course no waste, but where the demand for fresh milk is limited and production is considerably in excess of such demand the milk will have to be converted into cream or butter or cheese and these processes would always leave a certain amount of waste in the form of skim milk or whey. If, however, by some means these waste products could be converted into something of marketable value not only such waste could be prevented but the mother industry could be made more profitable.

Skim milk contains about 3% of the protein, casein, held in colloidal suspension. The latter is easily separated by precipitation with acids. On a large scale the separation is best effected by the addition of sulphuric acid. In the experiments referred to above, the precipitation was effected by mixing one and a half parts by volume of strong sulphuric acid with seven parts of water and adding the mixture to 1,000 parts of milk. The precipitated casein was washed, pressed to free it of superfluous water and dried in a draught oven at a moderate temperature and finally powdered as fine as possible.

A purer product can be obtained by dissolving the moist casein in the least possible quantity of ammonia and reprecipitating with acid. This process is repeated three or four times. The curd is washed several times with alcohol, extracted with ether in a soxhlet apparatus and finally dried.

Casein has been found to lend itself to an enormous number of uses in industry. The uses to which it is put is increasing year by year. There are probably very few industries in which casein does

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not or cannot advantageously get employed. Thus it is used in the manufacture of distempers, cardboard, paper glazing, leather dressing, soap manufacture, cotton sizing and water-proofing, calico printing, boot polishes, water proof cements, invalid foods, and imitations of bones, ivory, tortoise shell etc.

Casein Paints and distempers. Casein prepared in the manner above described is soluble in solutions of the hydroxides of the alkali and alkaline earthy metals and in many cases of their salts as well, although the quantity of each required for complete solution is different in each case. Thus of sodium hydroxide 1¾%, sodium carbonate 2¾%, sodium bicarbonate 3½%, sodium tungstate 12½% of the casein are required for complete solution. Solutions of borax and ordinary soap also dissolve casein.

Casein similarly dissolves in lime water although to a less extent, but the casein-lime compound thus formed has the property of absorbing carbon dioxide from the air and forming an insoluble compound. It is this property of casein which lends itself to the preparation of casein paints and distempers. These consist of mixtures of casein and slaked lime along with suitable pigments. On the addition of water the casein and lime combine to form a sticky soluble product holding the pigment in suspension. When applied to any suitable surface—wall, timber, or iron, the casein-lime compound in the prepared distemper absorbs carbon di-oxide from the air forming an insoluble durable coating which does not wash or rub off.

The proportions of the various ingredients forming the mixture is important. Too little lime would tend to make the product insoluble and too much would induce the paint to come off in flakes. Similarly too little paint would make the coating brittle and liable to flake off while if too much, the paint will rub off and not stand washing. Further, not all pigments could be used in the mixture, but only those which are not affected by lime. It is, however, possible to select suitable pigments to cover a full range of colours.

White paint may be made up of 100 parts each of casein and lime, levigated chalk 800, borax 1, and ultra-marine 2 to 3 parts by weight, while coloured paints may consist of similar proportions of casein and lime 400 each of levigated chalk and pigment, and borax one part. The ingredients should be all finely powdered and thoroughly dry. The mixture when stored in air-tight boxes will keep indefinitely.

For use, 50—60 parts of water are added to 100 parts of the powder and stirred until the mass is homogenous and free from lumps. This is then covered with a thin layer of water and set aside for the space of about one hour, after which the mass is stirred with more water to the consistency of oil paint. The paint thus prepared should be used without delay as it is liable to set hard in a comparatively short time, becoming unfit for use in twelve hours. The paint which

can be applied to any clean surface such as lime, plaster of paris, cement, brick, timber, stone, metal or canvas dries quickly with a mat surface and after 36—48 hours can be washed without fear and will stand the weather. The painted surface can be varnished if desired, painted or stencilled on. A glossy paint for indoor use can be produced by spraying the surface with a mixture of turpentine and wax and polishing it afterwards.

Casein adhesives. When dissolved in caustic alkalies or their salts, casein has adhesive properties and as such could be applied to the preparation of glues and cements, either liquid or solid, the solid glue only requiring to be dissolved in water for use. They find use for various industrial purposes, especially in wood work as they are ready for immediate use without previous soaking and heating as in the case of ordinary glue.

Two specimens are on exhibit, one prepared with borax and the other with soap. In one the borax serves as a preservative. The other requires the addition of an antiseptic as thymol or carbolic acid or lysol in order to preserve it.

Photographic films. Casein has been used in place of celluloid in the manufacture of photographic films, and in place of gelatin for coating the photographic plate or film, the sensitised "emulsion" in the latter case consisting of a solution of casein holding the halide salts of silver in colloidal suspension. Photographic paper similar in most respects to gelatine-chloride or bromide paper have also been prepared for printing from negatives or for enlargements.

The paper used for the specimen photographs on exhibit was obtained by coating ordinary paper with a solution of casein in citric acid to which a little glycerine had been added to give the paper the requisite pliability. The coated paper was, after drying in the shade, drawn over a 5% solution of ammonium chloride to render the casein insoluble, dried, sensitized in the dark room by floating in a 10% solution of silver nitrate and again dried in the dark room. Prints were obtained as on ordinary P. O. P., the operations of toning and fixing being also the same as with P. O. P.

Boot and shoe polishes. Casein has been found useful in the preparation of shoe and boot and furniture polishes, the casein in such preparations serving the purpose of a protective colloid holding in suspension considerable quantities of the other ingredients, usually wax or paraffin, turpentine and colouring matter. The samples exhibited have been prepared by dissolving casein in a solution of ordinary soap and incorporating with the mixture about twice the quantity of turpentine. A certain proportion of shellac dissolved in borax is also added to give the requisite gloss and finally the colouring matter which in the case of brown polishes may be an extract of

annatto and in black polishes, ordinary lampblack in a fine state of division.

Alimentary Casein. Casein being the chief protein material in milk is of considerable food value and possessing as it does good keeping qualities and no objectionable taste or smell has found favour in the preparation of several alimentary products, some of these being peculiarly suited for invalids. Thus, patent foods have from time to time been placed on the market under the names, Plasmon, Eucasein, Vitafer, Sanagen, Sanatogen, etc. The composition and the process of manufacture of these are not known with certainty but from knowledge gained by their chemical analysis it is possible to imitate them closely. Thus a product similar to Plasmon which is a soda compound of casein is obtained by mixing together 80 parts of casein containing about 5% of fat, 7 parts of sodium bicarbonate and 13 parts of lactose. Eucasein, which is a casein ammonia compound, could be prepared by passing ammonia through casein suspended in alcohol and afterwards separating and drying the casein. A product closely resembling Sanatogen is obtained by dissolving casein in sodium glycero-phosphate, evaporating the viscous mass to dryness in vacuo and reducing the dried mass to fine powder. Samples of these products obtained in the manner above mentioned are on exhibit.

Casein solids – Galalith. By suitable treatment casein could be converted into a plastic mass which could be moulded or pressed into various shapes, the finished product resembling horn, ivory, or tortoise shell according to the manner of treatment. The products are known as Galalith or Lactoform. The plastic mass after being hot-pressed in hydraulic presses is hardened by immersion in a solution of formaldehyde the length of treatment varying from 2—30 weeks, according to the thickness of the articles. A variety of articles can be made from Galalith, e. g., brush backs, combs, cigarette holders, electrical fittings, umbrella and stick handles, buttons, etc. The articles thus made are uninflammable unlike celluloid.

Lactose. The whey drained off the curd in the manufacture of cheese contains most of the lactose present in the original milk and could be recovered. The method adopted consisted in first precipitating the milk albumen present in the whey by the addition of acetic acid and warming and then removing it by straining through cloth. The clear liquid was evaporated down on the water bath until the liquid showed signs of turning brown after which it was concentrated in vacuo until a syrup was obtained from which the sugar crystallised out on cooling. The first crop of crystals was quite white after having been washed in a fine spray of water. The mother liquor on treatment with bone charcoal and concentration in vacuo yielded a further quantity of brown coloured crystals.