the producing season and having the equipment standing idle for about half the year.

Refining processes should be improved so as to remove nothing but the unwanted ingredients of the crude oil, that is, the free fatty acids and the non-fatty organic matter. An oil containing one per cent of free fatty acids and one per cent of organic matter, which refines according to the present kettle process with perhaps 6% loss, should be refined with a loss of but little more than 2%.

Bleaching methods will be improved with possibly the substitution of chemical agents for fullers earth, with reduced loss of oil in the operation, and obtaining lighter colors, which should eventually approximate water-whiteness.

Deodorizing processes should be perfected to yield a more perfect product in a much shorter time. Besides being tasteless it should not give off any odor at any temperature used in frying. There seems no good reason why four to eight hours' treatment, for example, should be required to remove the minute percentage of odors from cottonseed oil as required by present processes.

Hydrogenation should be further perfected, especially in the direction of speed, selectivity, and flavor so that all the unsaturated constituents subject to rancidity may be readily hydrogenated with little if any action on the more stable constituents, and without introducing the odor and flavor caused by present hydrogenation procedures.

Many other possibilities exist. There is no reason to think that we have reached or even closely approached the limit of improvements which chemistry can offer to the cotton seed industry, and I have no doubt myself that the next 25 years will bring about changes just as important as those of the past 25 years.

Some Nutritive Developments in Soybean Products*

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SOYBEAN products have enjoyed a rapidly increasing importance in the United States during the past few years. According to the Bureau of Agricultural Economics soybean oil as recently as 1930 accounted for less than 1% of the production of vegetable oils from domestic materials in the United States. But in 1936 soybean oil had grown to 12% of the domestic vegetable oil production.

Soybean products during this same period have won for themselves increasing importance in the field of nutrition. In 1931 only 31½% of the soybean oil produced found its way into edible products. According to figures just compiled by the Statistical Committee of the National Soybean Oil Manufacturers' Association 85.3% of the domestic soybean oil produced in 1936 was used in edible products. 95.5% of all soybean meal produced in 1936 was used in feed, or food, while only 1.8% was used for technical purposes, such as plastics, glues, or caseins.

It is the purpose of this discussion to review a few of the nutritive developments in soybean products which are partly the reason for the popularity for these products for edible uses.

One of the reasons for the rapidity with which soybean oil meal has won favor as an ingredient in livestock feeds is because of its high biological value. In a series of biological assays made in the Purina Mills Laboratories, on white rats as the test animal, expeller type soybean oil meal of high quality showed the highest biological value of protein of the ingredients tested and exceeded even dried skimmed milk and fish meal in growth factors. The relative biological values found are as follows:

Each sample tested represented a composite sample of a car of the ingredient.

Expeller type soybean meal	(6 samples)	100
Dried skimmed milk	(6 samples)	92
Menhaden fish meal	(6 samples)	82
Milk albumen	(1 sample)	82
Sardine meal	(43 samples)	79
Liver meal	(2 samples)	64
Corn gluten meal	(1 sample)	49
Meat scrap	(26 samples)	41

Unfortunately not all samples of soybean oil meal have the same high biological value. Some samples tested had only half the biological value of other samples. This same wide variation, however, is found with fish meals and meat scraps depending upon the source of supply of raw material and method of production.

When one remembers that the soybean is not one uniform product, but that there are literally hundreds of types and strains—that over twenty well known varieties are commercially available in quantity, it is easy to see why soybean oil meal and soybean oil may vary from week to week and from oil mill to oil mill. It is possible that certain varieties of soybeans or even soybeans raised in different localities vary considerably in the combination of amino acids which make up the protein. The United States Department of Agriculture have assayed a number of varieties of beans which showed considerable variation in their amino acid composition.

Hayward, Steenbock, and Bohsteadt in 1936 in studying the effect of heat as used in the production of soybean oil found that "raw soybeans contained protein of low nutritive value as determined by grams of growth per gram of protein eaten."

"Commercial soybean oil meals, such as the expeller meal processed at low temperatures, 105° C. for 2 minutes, or the hydraulic meal at 82° C. for 90 minutes, contained protein similar in nutritive value to raw soybeans. However, commercial soybean oil meals which had been prepared at medium and high temperatures, such as expeller meals processed at 112° to 150° C. for 2½ minutes, or hydraulic meals at 105° to 121° C. for 90 minutes contained protein of about twice the nutritive value of raw soybeans, or low temperature meals."

"The food intake of all rats which received either the raw or heated soybean diets adlibitum was found to be similar for the first few days of the feeding period. This sug-

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gested that the poor growth resulting from the raw soybeans and low temperature meals was due to some deficiency in these constituents rather than to a lack of palatability."

"When casein was incorporated in the diet which contained ground raw soybeans, normal growth resulted. These results suggested that the deficiency in the soybean existed in the protein fraction."

"Heating the raw soybeans to a high temperature in the expeller method of oil production caused an increase in the digestibility of 3% and an increase in the biological value of the protein of 12%."

Another of the nutritional developments of the past two years is the importance of vitamin G in feedstuffs to promote growth and to increase the hatchability of eggs. Dried skimmed milk has been quite generally considered a standard for comparison of vitamin G. Dried skimmed milk has been shown by Cornell to have about 5 Sherman rat units per gram. The Biological Laboratories of the Purina Mills shows 5 to 6 units per gram of milk. The grains are low in vitamin G. Cornell reports barley as .125 Sherman units, buckwheat .125, yellow corn .25, corn gluten meal zero, oat groats .125 units. Cornell also shows approximately 1.5 units for fish meal and 1.5 units for meat scrap. Purina Laboratories found one unit for Menhaden fish meal and 1.25 units for 55% protein meat scrap.

Purina Biological Laboratories find 2½ Sherman rat units vitamin G per gram of high grade expeller type soybean oil meal. Thus soybean oil meal of good quality has approximately half the vitamin G of dried skimmed milk, about twice the vitamin G of 55% protein meat scraps, or 60% fish meal and 20 times as much as the common cereals.

Frey, Schultz, and Light (1936) have reported that vitamin A activity of carotene is destroyed within a few minutes when the carotene is in contact with ground whole soybeans in the presence of oxygen. They also report that the heating of the soybeans above 50° C. inactivates the soybeans so that no destruction occurs.

In the Biological Laboratories of the Purina Mills more than 100 assays have been made of carotene soybean oil meal mixtures. These assays show no abnormal destruction of the carotene when used with soybean oil meal produced by the expeller process where temperatures above 50° C. are always used in good pressroom practice.

It is now generally recognized that some proteins have greater biological value than others. It is also generally recognized that a mixture of several proteins usually give a better result than any of the proteins separately. One protein may furnish an excess of one or more amino acids. Another protein may lack one or more amino acids. When several proteins are mixed the amino acids of one support a shortage in another in such a way that satisfactory result is obtained.

Although much more has been done in balancing the protein of feeds and food and in supplying proper vitamines and minerals little attention has been given to the proper place for fat in the ration. All fats were considered to be of equal value and the only place they were seriously considered was in the diet of the human female.

Burr and Burr in 1927 and in 1929 convincingly pointed out that all fats are not alike in their physiological value. They also pointed out that certain fats were essential to growth and general well being.

Burr and Burr and others have shown how a fat deficiency produces retarded growth which is more marked in the male than in the female animal. In the case of white rats on a fat deficient diet an abnormal scaly condition of the skin developes. Eczematous spots appear throughout the entire length of the tail. Ridges form on the tail and necrosis of the tail result. The hind feet become red and swollen. The hair is filled with dandruff like scales and a tendency for the loss of hair is apparent. The urinary tract and kidneys become involved and ultimately death results.

Later work by the Burrs 1929-1930 showed that it was principally linoleic acid which was effective in curing this fat deficiency. McCollum and Becker 1933 observed that "a diet containing everything else which is essential, but lacking in linoleic acid will fail to maintain life. It (referring to linoleic acid) must then be provided in the food."

Baughman and Jamieson found that a sample of soybean oil made from Mammoth Yellow Soybeans by an Anderson expeller contained the following acids:

Linoleic	49.3
Oleic	32.0
Palmitic	6.5
Stearic	4.2
Linolenic	2.2
Other acids	the remainder

Thus soybean oil is very high in this important food accessory linoleic acid which has been sometimes called vitamin F. It is of the common oils second only to linseed oil in the quantity of this factor available.

During the past two years a number of interesting cases of persons with linoleic acid deficiency have come to our attention. One was a young man, who had had a nutritional eczema for several years. He was allergic to many foods. He had been on a very restricted diet without milk, eggs, or fats. He had developed a dry eczema which did not respond to treatment.

His physician first prescribed corn oil, but the doses were so large as to upset his digestion. The doctor then prescribed smaller quantities of selected soybean oil and the eczema responded to treatment although there have been several recurrences of the eczema when treatment is stopped.

Another young man was born without sweat glands in the skin. The skin was always rough and dry. A high level of soybean oil in the diet helped the dry skin somewhat but a few months after treatment started, a heavy growth of hair developed on arms and chest. In another case an eleven year old boy had been ill and on a restricted diet. He lost most of his hair. His doctor prescribed a high level of soybean oil in his diet with the result of a rapid regrowth of his hair.

A few years ago the most serious problem of the mixed feed manufacturer was to secure an adequate quantity of the proper proteins. Today, many high grade proteins, especially from vegetable sources, are available. But as the machinery has been improved and as pressroom methods have advanced the oil meals have become lower and lower in fat. The problem of the mixed feed manufacturer has changed until now it is a problem to get enough fat of the proper quality in the ration.

The function of fat in the diet is just as important as the function of protein or carbohydrate or mineral. Certain fatty acids are of more value than others. Certain fatty acids apparently cannot be synthesized from others or from carbohydrates. It is our belief that the subject of fat should receive and will receive more attention since the quantity and kind of fat remaining in the oil meal is important to the feed manufacturer and has a large influence on the biological quality of the oil meal produced.

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THE ESTIMATION OF WATER IN SALAD OIL AND DETERMINATION OF ITS SOLUBILITY AT ORDINARY TEMPERATURES*

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Method for Moisture Determination:

The common methods of drying in a vacuum oven, or heating fat or oil in an aluminum dish on a hot plate to the smoking point are not particularly suited to the accurate determination of small amounts of moisture in salad oils, or even in other fats. The objections to these methods do not require comment here. It seemed that a distinct need existed for a method which would permit the determination of small amounts of water in oils preferably by weighing the water evolved after absorption in some suitable medium. A simple apparatus was devised in which 10 to 50 gram samples of the fat or oil were dried in a current of inert gas at elevated temperatures, the moisture being subsequently absorbed in a neutral medium such as fused calcium chloride. In Figure I the details of the apparatus are illustrated.

Ten to fifty grams of sample, depending on the moisture content are weighed into dry evolution tubes "T" (1 by 8 in. Pyrex). These are attached to the blowing system by means of a tight fitting rubber stopper carrying inlet and outlet tubes. Hydrogen from a cylinder is passed through the fused calcium chloride in drying tube "D" and thence through the flow control capillary "F" and then through the oil. The effluent hydrogen is passed through absorbent cotton in a small bulb "G" to remove any entrained oil. Moisture is absorbed in U-tube "A" with "B" serving as an auxillary to indicate that absorption is complete. "C" merely serves as a guard tube to the train. Fused calcium chloride was used as the absorbent although any other absorbent should be satisfactory. After enough hydrogen has been passed to sweep the air out of the oil, the temperature of the oil bath is raised to 130° to 140° C. and held there until the oil is dry. Tubes "A" and "B" are disconnected from the system and weighed. The increment in weight of the two tubes corresponds to the moisture in the sample. The tubes are replaced in the system and the train is ready for the next determination.

TABLE I.—RATE OF MOISTURE REMOVAL FROM COTTONSEED OIL SALAD OIL

25.7 gm. Sample, 0.062% Moisture.

Run Mins.	Actual Wts. Gms. Tube "A"	Actual Wts. Gms. Tube "B"	Mgms. Change Tube "A"	Mgms. Change Tube "B"	Total Moisture Obtained Mgms.	% Total Obtained
0	42.3660	50.1730	...	...	...	....
5	42.3750	50.1730	9.0	0	9.0	56.3
10	42.3785	50.1735	12.5	0.5	13.0	81.4
20	42.3800	50.1735	14.0	0.5	14.5	90.8
30	42.3810	50.1735	15.0	0.5	15.5	97.2
40	42.3810	50.1740	15.0	1.0	16.0	100.
60	42.3810	50.1740	15.0	1.0	16.0	100.

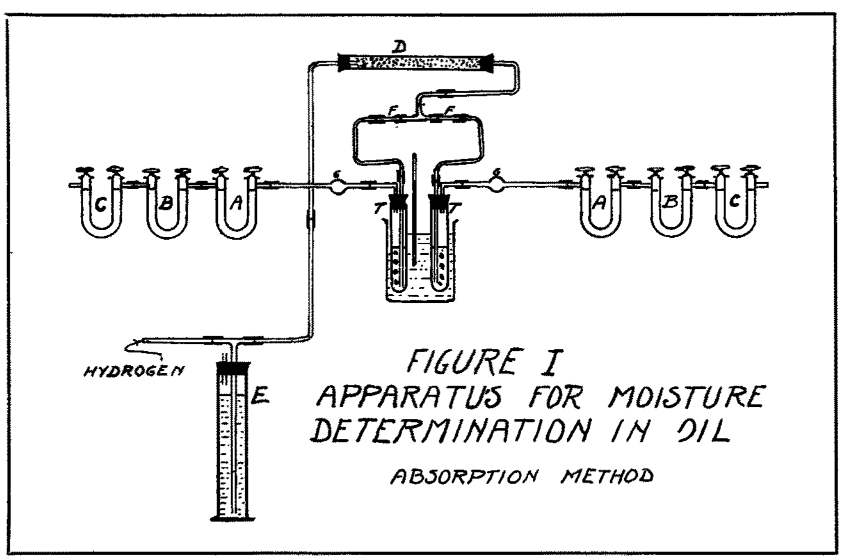

FIGURE I
APPARATUS FOR MOISTURE DETERMINATION IN OIL
ABSORPTION METHOD

Time Required for Evolution of Moisture:

It seemed advisable to determine the rate at which moisture was removed from the sample under the conditions of the method using about 100 cc. of hydrogen per minute through the system. In Table I the data is given for a typical run designed to measure the rate of moisture removal. It will be seen that the water is removed to within the accuracy of the weighing (± 0.5 mgm.) within 30 minutes. As a factor of safety, the evolution period was usually set at one hour.

Results Obtained With the Method:

In Table II a series of analyses representing samples of various types of salad oils selected at ran-

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