

fatten rapidly on pea meal, or on the oil cake of nuts or of meat; but very slowly on potatoes, artichokes, or beets, though the latter are much richer in starch and sugar, but less so in protein or in fat.

Still further, all observations upon our domestic animals accord in showing that the fat and the protein of forages suffice to explain the formation of the fat found in the animal or its products, without any help from the hydrocarbons. Some sweet or starchy foods may, it is true, in certain cases, appear greatly to favor the accumulation of fat; but this is in the case of a ration insufficient in respiratory principles; or in which a great part of the fat and the protein of the food is compelled to serve for warmth, instead of being assimilated."

JULES CREVAT. (1)

Many years ago, when I had gained a considerable degree of proficiency in the practical part of farming, I was naturally inclined to turn my mind to the study of its theoretical side. At that time, about 1841-'48, the great authority on the theory of farming was the illustrious Baron Liebig, the great German chemist. From a careful study of his works, I gained a vast fund of information; some of this I have no doubt forgotten, but the larger part remains by me to this day.

Among the various lessons taught me by the great scientist was one, connected with the nutrition of animals; in effect, it showed that the chief source of fat is non-nitrogenous matter, such as starch, sugar, &c. These are not the exact words of the Baron's statement, but they convey his idea, as I recollect it.

"There is another constituent of the animal body, namely, fat, the production of which deserves notice. It is not an organised tissue, but is formed and collected in the cellular tissue under certain circumstances. These are, rest and confinement,—that is, a deficiency of oxygen, and an abundance of food containing a considerable proportion of non-azotised matter, such as starch, sugar, &c. . . . Now the chief source of fat is sugar, the composition of which is such, that when deprived of oxygen fat remains. . . . It is obvious, therefore, that fat can only be formed by a process of deoxidation. But it is produced when oxygen is deficient; and it appears, as Liebig has pointed out, that, when there is a deficient supply of oxygen, the production of fat, which is the consequence of the deficiency, yields a supply of that element, and thus serves to keep up the animal heat and the vital functions, which would otherwise be arrested. This is another beautiful instance of contrivance equally simple and wonderful. That fat must be formed by the deoxidising process is proved by the phenomena of the fattening of animals. A goose tied up, and fed with farinaceous food, altogether destitute of fat, acquires in a short time an increase of weight of several pounds, the whole of which is fat. Again, the bee produces wax, a species of fat, from pure sugar."

Turner's Elements of Chemistry.

I am told, by those whose ought to know, that this position of the great German is now disputed by some of his own countrymen. In England, however, and in this country, all the leading men whom I have consulted take Liebig's side of the question, just as,

(1) For this translation of M. Crevat's work I am indebted to Dr. Hoskins, formerly Agricultural editor of the *Vermont Watchman*.

in practice, the goose and the bee in the passage just quoted do.

For instance: Dr. Girdwood, Professor of chemistry at McGill college, Montreal, and a practical farmer too, told me, the other day, that he had not the slightest doubt about the truth of the principle that the carbo-hydrates, or non-azotised parts of the food, are sources of fat in the animal economy.

Dr. Baker Edwards, the well known analytical chemist, who has been so successful in his dealings with the milk-vendors of our fair town, holds the same position most strongly, and Mr. Penhallow, professor of Botany at McGill, has no doubts on the subject.

What says Mr. E. W. Stewart, the author of "Feeding animals," whose answers to enquirers on that subject are so well known to all the readers of *The Country Gentleman*?

"Carbo-hydrates are composed simply of carbon and the elements of water—hydrogen and oxygen, non-nitrogenous compounds. The principal of these are woody fibre, starch, gum, and the various kinds of sugar. This is the food that keeps up animal heat, and the surplus goes to lay on fat in animals."

Mr. Henry Gray, a member of the Sanitary Board, and a man thoroughly acquainted with farming as well as a practical chemist, writes to me as follows:

Dear Sir,

I cannot understand how the people you speak of can lay down the dogmatic assertion that the Carbo-hydrates cannot be transformed into fat.

Stewart on feeding &c., no mean authority, tells us that "Lawes and Gilbert carried out a thorough series of experiments on pigs that fully corroborated Liebig's views and proved quite decisively that carbo-hydrates were transformed into fat"; and he furthermore tells us that it has been stated that Pottenkofer, Wolff and other German chemists who had held different views have recently acknowledged the correctness of the Lawes and Gilbert experiments.

One of the first rules laid down by medical specialists in treating corpulency is not to eat food containing starch, sugar, or gum. Even the little negroes on the Southern plantations used to wax fat as the sugar cane ripened, especially if they were big enough to run about with a piece of well sucked cane in their hands.

To say the least, the assertion is entirely in opposition to a fact which it appears to me has only recently been well established and I should much like to hear the opinions of men better posted than myself on this important subject. Truly yours,

HENRY R. GRAY.

Mr. Thomas Macfarlane, the Chief Government analyst, of Ottawa, has been kind enough to send me his opinion; it reads thus:

Laboratory of the Inland Revenue
Ottawa

A. R. JENNER FOST, Esq.,
Editor *Journal of Agriculture*,
Montreal.

Dear Sir,

I am in receipt of your favour of yesterday and in reply would state that I have always been under the same impression as yourself and Dr. Girdwood regarding the formation of fat from the carbo-hydrates, I must add however that I have no experience of my own on the subject. Among the authorities I observe that Stewart in his book "Feeding Animals"; (p. 38),

asserts that animals "are also able to store up fat from the carbo-hydrates." On the other hand König, in his "Nahrungs und Genussmittel," says the matter is still in doubt. He writes: "according to now experiments it appears that a production of fat from the carbo-hydrates is more than probable in the case of graminivorous animals and the pig, but it is denied that this takes place in the case of flesh eaters." Yours truly,

THOMAS MACFARLANE.

Mr. E. W. Stewart mentioned above, says in his "Feeding Animals," when treating of the formation of flesh and fat:

"The popular idea had been that all animals, except the fattest, contained more flesh than fat; but Lawes' tables refute this idea most conclusively. The fat ox and fat lamb contain about three times as much fat as lean flesh."

"Mean of six fat and very fat animals; carcass:

Lean flesh, 12.30%—Fat, 39.70%."

Therefore, I conclude that the comparatively small percentage of fatty matters and albuminoids contained in the food cannot be the source whence all this fat is derived.

Again, Mr Stewart says:

"Oil has a great effect in the rapid fattening of animals, but they are also able to stow up fat from the carbo-hydrates."

"The animal possesses the power of preparing fat from starchy food when there is not fat enough ready formed for its wants."

"Almost all fodder contains fat, but not in quantity sufficient to account for all the fat laid up by the fattening animal, or the fat in the milk of the cow." Please observe the last words of the above sentence.

"Voit, Pottenkofer, and other German chemists were inclined to doubt if the carbo-hydrates were ever used to produce fat, as Liebig had held many years before; but Lawes and Gilbert in their experiments on "Pig-feeding" fully and decisively proved that carbo-hydrates are transformed into fat. The pigs were fed upon barley-meal, and the fat and albuminoid matter in the barley-meal were wholly insufficient to account for the fat formed in the bodies."

And now comes Mr. Stewart's expression of the opinion of practical feeders as confirmed by practical experiments conducted by skilled experimenters, thoroughly familiarised with the management of tests:

"The practical common sense of feeders has taught them that foods having a large proportion of starch are particularly adapted to produce fat, or milk rich in butter, and these impressions, derived from general practice, have withstood all the doubts of scientific investigators based upon inadequate experiments."

"We saw one case of three pigs fed upon corn-meal, prepared in the best way to induce them to eat largely of it with the expectation of producing a large growth at an early age. The result was, that at 130 days old, these pigs were mere squabs of fat."

"The sugar of milk is very soluble and will lay on fat rapidly if the other constituents are added."

Lastly, the Professors of Chemistry at the Central Experimental Farm, at Ottawa, have kindly sent me the following expression of their opinion on this matter:

Ottawa, Nov. 6th. 1893.

This is a question regarding which there is still much difference of opinion among physiologists, and towards the solution of which there are many experiments now in progress by German and other scientists.

Of late years the results of experiments carried on in Germany have corroborated the results obtained by Messrs Lawes and Gilbert, of England, who, I think, have clearly shown that fat in the animal may be, and often is, formed from the carbo-hydrates. This was predicted years ago by the celebrated chemist, Liebig; but later was discredited by his own countrymen, who held that their experiments proved that fats were produced in the animal economy exclusively from fats and albuminoids in the food, and, further, that the sole function of the carbo-hydrates was to produce heat and energy.

Although there can be no doubt that the greater part of the fats in the body are produced from fats and albuminoids of the food, it is also doubtless true that a part of such often is formed from the carbo-hydrates.

It should not be lost sight of that very important function of the carbo-hydrates in the animal is to preserve or protect the fats formed from undue waste.

Yours faithfully,

FRANK T. SHUTT, M. A.
Chemist.

Carbo-hydrates, in a food, are not only productive of heat and energy in the animal, but also serve as sources of fat. As they contain no nitrogen, they cannot act as flesh producers.

Sugar is a well known fattening agent, and, as starch is converted into sugar by the digestive juices it must also act in the same manner.

P. H. ROSSIGNOL,
Asst. Chemist.

So much for the authorities on this side of the Atlantic; now, turn we to the English writers on this subject.

Mr. F. J. Lloyd, Fellow of the Chemical Society, and one of the leading Professors of Agricultural Chemistry, holds, as you will see, very strong opinions as to the power animals have of appropriating the non-nitrogenous constituents of their food and converting it into fat.

Some time ago I wrote to him to know if he had any knowledge of a theory that I had heard bruited abroad here, viz, that in no case are the carbo-hydrates of food converted into fat in the animal economy." Warrington," said my letter, "Claude Bernard, Lawes and Gilbert, Dumas, Milne Edwards, E. W. Stewart, an American writer, and Liebig, all, as far as I recollect, hold that starch, sugar, &c., are sources of fat. Practically, I am sure that the carbo-hydrates are converted into fat, but I should like to know the last decision of science on the subject." To this Mr. Lloyd replied as follows:

"I cannot understand how the views stated by Mr. Jenner Fust, can be promulgated by any scientific man without very remarkable evidence to support them, in which case they would probably be better known. Our present view is as stated in the letter—(i. e. that the carbo-hydrates are convertible into fat.)

(Signed) F. J. LLOYD.

Some of you may have met with a little book named, "The Chemistry of the Farm, by another Fellow of the Chemical Society, Mr. R. Warrington. This gentleman was selected to con-