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### THE YELLOW COLOR IN CREAM AND BUTTER

I. S. PALMER

The natural yellow color of cream and butter is one of the most variable characteristics of these two dairy products. White cream and pale yellow butter are just as natural as yellow cream and rich-colored butter, but the consumers of dairy products have somehow associated a greater value with the better colored products. In popular opinion yellow milk is rich milk, and milk lacking in color is thin and inferior. So strong is this belief that butter lacking a yellow color is almost unsalable. As a result of this demand most butter makers use a harmless vegetable coloring matter, allowed by the pure food law, during the winter season when the natural color of the butter is a very light yellow. It has not yet been found possible to supply so easily the public demand for yellow milk and cream, so the consumer still complains of what he thinks is the thin milk and cream which he gets at certain times of the year, particularly during the winter months.

Experiments recently concluded at the Missouri Agricultural Experiment Station have cleared up a great many points about yellow and white cream and butter that have heretofore been little understood. Among other things, the natural yellow coloring matter of these products has been identified, and the cause of its variation discovered. The relation of the coloring matter to other similar pigments in the cow's body has also been shown, and some information gathered as to the relation of the various breeds of dairy cows to the amount of color they give in their cream and butter. The experiments have, in addition, made it possible to determine in advance when a cow may be expected to produce yellow colored products and when the colorless products may be expected. In fact, the whole question of the natural yellow color of dairy products can now be put upon a scientific basis as the result of these experiments. A brief summary of the work and some of its practical applications are set forth below.

**Cause of the Natural Color of Cream and Butter.** General observation for many years has shown that plenty of fresh green forage for the dairy cow means yellow cream and butter. The experimental studies to ascertain the exact relation between the fresh pasture grass of spring and the deep yellow butter that always results gave the clue to the whole question of yellow or white products. The general belief has been that nature provides the materials in the grass out of which the cow can in some way manufacture the yellow color for the milk. It was found, however, that a very simple relation exists between the feed and the color of the cream and butter. Instead of nature providing the materials for the cow to work with, it was found that nature provides the coloring matter itself. Fresh green feeds of all kinds are rich in yellow pigments, or coloring matters, which are covered to the eye by the green color of the plants, which is called chlorophyll. There are two classes of the yellow pigments found accompanying the chlorophyll. One of these is called carotin, the name being taken from the pigment of the carrot, where it was first discovered by scientists over one hundred years ago. The other class of yellow pigments is called xanthophyll. The latter is really the more abundant of the two yellow pigments in green plants.

A study of the yellow pigment of butter showed that it was identical with the carotin of the green feeds and of carrots. This result indicated that the lack of yellow color in cream and butter when feeding certain feeds was probably due to the fact that these feeds contained little or no carotin. This was found to be the case. A classification of the dairy feeds according to the amount of carotin contained, showed that the feeds with little or no carotin are those which the cow ordinarily gets during the winter months, when cream and butter are white. The feeds rich in carotin are, in all cases, those known to make the cream and butter yellow. As a definite proof of this relation between the feed and the color of the milk and butter, it was found possible to vary the color of these products from a deep yellow to white by selecting carotin-rich or carotin-poor feeds. It is of special interest to note that this was found to hold true for all breeds of dairy cows studied. It must be said, however, that the feeds very rich in carotin did not produce as yellow products in the case of Holstein, Shorthorn, and Ayrshire cows as they did in the case of Jerseys. All the breeds were alike, however, in producing white cream and butter on the carotin-poor rations.

In the following table a number of the ordinary dairy feeds investigated are listed with respect to their content of carotin, the pigment that goes over into the milk.

Carotin-rich Feeds	Carotin-poor Feeds
Green pasture grass, especially when fresh in the spring or fall	All hay that has lost its green color in curing, such as most timothy and clover
Hay, cured with a large part of its original green color, such as most western-cured alfalfa hay	Dry corn fodder (corn stover)
All soiling crops	All corn silage, except when very new
Green corn fodder	Straw, all kinds
Very new corn silage	Corn, both yellow and white
Carrots, and other yellow roots and tubers	Wheat
	All so-called by-products, such as wheat bran, brewers' grains, cottonseed meal, linseed meal, etc.*

The foregoing table shows that there are relatively few feeds that furnish an abundance of carotin for the cream and butter, and of these there is only one that cows ordinarily receive as their sole ration, namely, pasture grass. Soiling crops, when used, are of course in the same class as pasture grass. These are the feeds that contain the greatest amount of carotin and impart to the cream and butter its deepest color. They are the summer feeds. The table shows that the winter feeds in nearly every case are the feeds that contain little or no carotin. Practically the only exception is hay cured with its original green color. Although quite rich in carotin it cannot be expected to give the summer color to butter when forming only a part of the ration. The experiments showed that such hay in the winter ration undoubtedly has a beneficial effect on the color of the butter compared to a ration containing practically no carotin. The point to be borne in mind is that the amount of color that a cow will take out of her feed and put into her cream and butter depends almost entirely on the amount of carotin furnished in her entire feed. The only other influencing factors were found to be the amount of butter being produced, which would naturally be expected, and the breed of the cow. The latter factor will be discussed presently.

It is to be noted that even yellow corn is listed among the feeds that contain little or no carotin. The general belief is that yellow corn helps to make butter yellow, but this was found not to be the case in the experiments that were conducted. The reason for this is that the coloring matter of yellow corn is almost entirely xanthophyll, the other yellow coloring matter found accompanying the green

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\*A great deal of the gluten feed on the market has been artificially colored with a yellow vegetable coloring matter. It has not been ascertained whether this coloring matter will pass into the milk fat. Natural gluten feed may be classed with the carotin-poor feeds.

chlorophyll. Cows do not appear to be able to make use of this class of yellow pigments.

Contrary to what might be expected, corn silage is also classed among the carotin-poor feeds, except when very new. The explanation for this is that the fermentation changes that go on in the silage after it is put up, destroy the carotin that was in the green corn.

Considering the whole question of the relation of the feed to the color of cream and butter, it does not appear possible for the dairy farmer to materially help the usual white condition of his cream and butter during the winter months by feeding the cow any special feeds. Although it might be possible to select a ration that would help in this respect, it is very doubtful if it would be an economical thing to do. The consumer must be satisfied with the naturally colorless condition of his cream during the winter; and the butter-maker must use some butter color at this season of the year if he wishes to have yellow butter. In adding a vegetable color, he is only doing what the cow would do if she had the proper feed for that purpose.

**Relation of Color of Butter to Breed of Cow.** Experience has made it possible to classify the dairy breeds according to the color of the cream and butter produced. The Guernsey and Jersey breeds are ranked first in this respect, with the Ayrshire, Holstein and other breeds in a much lower scale. The difference between the high and low color producers has been believed to be as firmly fixed as the difference in the fat production of the two classes of animals. The experiments have shown, however, that some of the views about the breed difference with respect to the color production require modification. That differences do exist is not to be denied, but several points were brought out by the experiments that should be generally known. These may be summarized as follows:

1. No breed of dairy cows is able to manufacture the coloring matter for its cream and butter; the primary source must be the carotin in the feed. All breeds were found to be alike in producing white cream and butter on carotin-poor rations.

2. The whole question of breed difference is merely a relative one. The so-called low color producing breeds can give reasonably well colored products when fed plenty of carotin-rich foods, but not as high colored products as the Guernsey and Jersey breeds under the same conditions. The data collected on this point has led to the opinion being advanced that the breed difference in respect to color production has been over-emphasized.

3. No breed difference in color of the products exists immediately after parturition. The colostrum milk of all cows is very highly colored due to a relatively very large amount of carotin in the milk fat.

4. The whole question of the breed difference rests entirely on the fact that for some still unexplained reason, some breeds of cows make use of more carotin than other breeds when making their milk fat.

**Relation of Butter Pigment to Other Body Pigments.** Besides putting the carotin coloring matter from the feed into the milk fat, the experiments showed that cows also normally color their body fat with the same pigment. The body fat of Guernsey and Jersey cows, especially, is characterized by a high yellow color, which is due to the same pigment found in the milk fat. The body fat of other breeds, Holstein and Ayrshire, was found to be much less characteristic in this respect. In fact, the difference between the two former and the two latter breeds in this regard was found to be more marked than the difference between the two groups in the coloration of the cream and butter. It was found, however, that when the body fat of Jersey cows was laid on when feeding a ration poor in carotin that the resulting fat was colorless.

The normally greater amount of carotin in the body tissues, particularly the fat, of Jersey cows was found to exert a marked influence at times on the color of the cream and butter. When cows of this breed were put upon a ration containing little or no carotin, the tissues of the body rich in this coloring matter acted as a reserve upon which the animal drew for the pigment for the milk. It is in this way that cows of the Guernsey and Jersey breeds are able to keep up the color of their cream and butter for some time after withdrawing the carotin from the ration, while cows of the Holstein and Ayrshire breeds, under similar conditions, soon fall off in the color of their products, due to the lack of such a reserve storage of pigment. This is the explanation why Guernseys and Jerseys often appear to be producing yellow butter during the early winter on a carotin-poor ration, which has led more than anything else to the belief that cows of these breeds are able to manufacture the coloring matter for their products.

Besides coloring the butter fat and the body tissues, all cows carry considerable carotin in their blood. It is in this way that the carotin is transported from the food to the milk glands, where it somehow becomes a part of the milk fat. This being the case, it is not surprising that the amount of carotin in the blood was found to fluctuate with the amount the cow received in her feed and the amount she put into her milk fat. When the butter color was low, the amount of carotin in the blood was low, and vice versa.

It is a well known fact that the skin of Guernsey and Jersey cattle has a higher yellow color than other breeds, and this charac-

teristic is looked upon by cattle breeders as an indication of the ability of these breeds to produce highly colored cream and butter. The investigations of the various body pigments included the skin pigment, and it was found to be identical with the butter pigment and the yellow carotin of the feeds. The fat in the skin of these breeds stores the carotin like the fat in the other parts of the body, giving the skin a characteristic color just like the internal body fat of these breeds has a characteristic yellow color.

It is well known, especially to butchers, that many people have a prejudice against beef with a highly colored fat. The experiments here reported lead naturally to the question whether this is a reasonable prejudice when the pigment to which objection is made is the same as that for which people will pay a higher price when present in butter.

**Relation of Color to Quality of Cream and Butter.** It was stated above that the consumer of milk and cream has come to look upon a yellow color in these products as indicating that they contain a higher per cent of fat. This has come about largely because the breeds of dairy cows that are classed as high color producers are also those breeds whose milk is characterized by a high fat percentage. The popular belief that color and richness in dairy products are synonymous has led many people to assume that the high color obtained when cows first go onto pasture in the spring indicates a very great increase in the amount of fat in the milk. These beliefs have no foundation. The yellow color of milk and cream is due, of course, to the fat in the milk which carries the yellow pigment. There is no general relation, however, between the amount of color in the milk and cream and the amount of fat in these products. The only certain way to tell the amount of fat in milk is by the well known Babcock test. As a matter of fact, instead of cows giving a low per cent of fat in the winter when the fat is usually naturally colorless, it has been definitely demonstrated that cows on the average give a higher per cent of fat during the winter than they do in the spring and summer.

The belief in the relation of the color of dairy products to their quality has been extended to include the butter, and the public now demands a yellow product from the creamery thruout the year. It appears that this demand has no foundation as long as the other qualities of the butter are normal, except that the yellow product is undoubtedly more pleasing to the eye. There is no relation between either the taste or the nutritious qualities and the color of the butter, and it may be stated in addition that white butter is just as natural as yellow butter.