7:22 Canthaxanthin for meat product colouration

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I - Introduction

The food colouring agents advised by French Law for Meat Products and Curing are cochineal carmine (E 120), canthaxanthin (E 161g), anthocyanins (E 163), beet red (E 162). Cochineal and canthaxanthin are the most suitable colouring agents because anthocyanins and beet red are not stable when heated and are pH sensitive.

Until now, canthaxanthin was rarely used in meat product manufacturing. But new application forms have been elaborated and the colour range which can be obtained with this carotenoid now extends from orange to red-violet.

Colouring trials with canthaxanthin were applied to the most frequently coloured meat products and the behaviour of the colouring agent during the different manufacturing steps was studied.

Cochineal was chosen as a reference colouring agent because a lot of French meat products are coloured with this substance.

II - Canthaxanthin

Canthaxanthin belongs to the family of carotenoids (1,2). These colourants frequently occur in Nature. Furthermore, some natural extracts containing carotenoids have been used for centuries because of their colouring characteristics, for example, saffron, annatto, paprika and palm-oil. Some preparations containing carotenoids are available on the market. In the classification established by the joint FAO/WHO Expert Committee on Food Additives, β-carotene, β-apo-8'carotenal and canthaxanthin prepared by chemical synthesis are classified in class A (1). Therefore they are approved food colourants in most countries.

Chemically, the pure, crystallized colourant is the trans canthaxanthin and its structure is presented in figure 1.

Like most carotenoids, canthaxanthin (CXN) is water insoluble and special forms must be developed for its use in food products. According to the physicochemical distribution of canthaxanthin in the colouring preparation, it is possible to obtain hydrodispersible forms providing the meat products with colour shades ranging from orange to red-violet. The advantages of carotenoids prepared by chemical synthesis are their purity, uniform colour, and high tinctorial potency. The composition of the different application forms of canthaxanthin is reported in Table 1.

III - Material and Methods

1) Meat product Manufacturing

Different types of meat products are manufactured :

- raw products : sausage meat, fresh flat or farmer sausage
- raw products, scalded, smoked or not : cooking sausage, chorizo sausage
- dried and matured products : dry sausage, Danish salami
- sausages scalded in hot water or steam : garlic sausage, Frankfurter or Strasbourg sausage
- fish pâtés

The pilot trials are a good approach to industrial manufacturing conditions (see ref. 3 to 8).

2) Chemical composition

Analysis of the chemical composition of some of the tested products was made according to classical methods. The products conformed to the French Law for Meat Products and Curing (9).

3) Colour evaluation

In this study the colour was evaluated by a simple visual observation (organoleptic test) and by colour measurement with a Gardner automatic colorimeter XL 20.

This apparatus gives the 3 values L, a, b suggested by the International Commission for Lighting in 1976 (10). a and b define the shade and L characterizes the luminosity index. a and b are represented in two horizontal scales and L in a vertical scale (figure 2).

The closer L is to 0 the darker the colour is. The higher the positive values of a are the redder the colour is. The same can be observed with b and the yellow shade.

Furthermore the stability of canthaxanthin was tested in the finished product and, in some trials, during the different steps of manufacturing.

IV - Results, Discussion

All the trials are described in detail in publications 4 to 8. We shall only give the main observations here.

1) Choice of the application form of canthaxanthin

The form of canthaxanthin was chosen according to the shade required in the finished product.

The forms 1 % CWS, 10 % CWS and 10 % WS provide orange shades. They are thus suitable for products like chorizo, Frankfurter or Strasbourg sausage and salmon shaded pâtés.

Canthaxanthin pigment 10 %, type RVI is suitable for products with a violet shade, such as dry sausage, Danish salami, sausage meat, garlic sausage and certain pâtés. But it is not suitable for cooking sausage as it slightly solubilizes in the fat of such products during cooking and undergoes a colour change from violet to orange.

These different shades are illustrated in figure 3 by the colorimetric values a and b obtained with Frankfurter sausage samples coloured with the different forms of canthaxanthin ; the shade of the form pigment 10 %, type RVI is close to cochineal since colour areas are very close on the graph, whereas the other forms of canthaxanthin are more orange shaded which accounts for a much higher a value.

2) Mode of colourant incorporation

The application forms 1 % CWS, 10 % CWS and pigment 10 %, type RVI are fully suitable for being incorporated in a dry mixture with spices.

On the other hand, the canthaxanthin 10 % WS, dispersible in warm water, should be incorporated in an aqueous dispersion for colour spots might appear in the finished product because of the manufacturing temperature. However in the trials made with the form 10 % WS incorporated as powder, especially in Frankfurter and Strasbourg sausage, this phenomenon was not observed.

The application forms 1 % CWS and 10 % CWS might also be incorporated in an aqueous dispersion because they are readily dispersible in cold water. For canthaxanthin pigment 10 %, type RVI, this kind of incorporation is not suitable because the dispersion must be performed in warm water, with a very careful stirring to avoid agglomeration. However, the mode of incorporation (powder or aqueous dispersion) does not affect the colour of the finished product, as emphasized in figure 4.

3) Colour stability

Canthaxanthin content was determined, especially in salamis. The results reported in Table 2 show that the losses of canthaxanthin were negligible and the stability good in so far as the quantitative determination was not perfectly accurate. Other analyses of Strasbourg sausages and Frankfurters (Tables 3 and 4) confirm these results but emphasize that the incorporation of the colourant at the end of cuttering (sausages of serial A), which is sometimes practised by professionals, leads to apparent losses of colourant as the latter is distributed less homogeneously in the meat mixture.

The stability of canthaxanthin is generally not affected by the manufacturing process.

4) Organoleptic tests

The results obtained on salamis coloured with canthaxanthin pigment 10 %, type RVI and on chorizos coloured with canthaxanthin 10 % WS or 10 % CWS are presented. The colour was given marks from 1 to 9 (very bad to perfect). An interval of the average at the 95 % level of truth was calculated.

For the evaluation of salamis, the jury was constituted of 23 professional meat processors. Table 5 shows the range of marks obtained. Score 5 limited by a vertical line corresponds to a colour considered as correct. Only 2 of the salamis examined were rejected, i. e. the one corresponding to the control without colourant and the commercial sample A, the pink colour of which was considered very artificial.

The scores attributed to samples coloured with canthaxanthin were good but however lower than those of the carmine trials. Only sausages with an incorporation level of 0.9 g of canthaxanthin 10 % per kg meat mixture (trial 6) were not very appreciated as the colourant incorporation level was too high so that the colour was rather dull and lustreless. It should be pointed out that two of the three commercial salamis obtained scores lower than those of all the samples coloured which canthaxanthin. The latter got less favorable scores than the samples coloured with cochineal, but they were nevertheless well accepted by the jury only composed of professionals accustomed to the more red-violet shade of cochineal.

The organoleptic test of chorizo was also made by a jury of 14 persons. The results are given in Table 6.
All the products got good marks. The control sample, only containing mild red pepper, was slightly less appreciated as the different members of the panel seemed to prefer the most coloured chorizos and this accounts for the excellent score obtained by the commercial sample n° 8.

As far as taste is concerned, no significant difference was observed between trials. Canthaxanthin does not affect the gustative quality of the product.

Conclusion

Carotenoids are widespread in Nature and possess high tinctorial potency as colourants. Compared to natural extracts, synthesized carotenoids are available in constant supply of a predetermined quality.

During the present study, application forms of canthaxanthin liable to colour a very wide range of meat products were tested. The experiments showed that canthaxanthin 10 % WS or 10 % CWS, giving the finished product a red-orange shade, is perfectly suitable for colouration of finely ground cooked products, like Frankfurter and Strasbourg sausages, salmon shaded pâtés and raw meat products as chorizo. Moreover, colour measurements and a visual appreciation of various products often coloured with cochineal showed that canthaxanthin pigment 10 %, type RVI can be used instead into raw products, such as sausage meat, dry sausage, Danish salami. It was not possible to define an equivalence between cochineal and canthaxanthin pigment 10 %, type RVI in these products because of the variations of quality of cochineal and because of the nature of the products to be coloured. However, in these trials, it was possible to determine the incorporation levels of canthaxanthin.

The products studied are not exhaustive and canthaxanthin might probably be used for colouring most meat products.

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TABLE 1 : APPLICATION FORMS OF CANTHAXANTHIN

Form	Carrier material	Solubility	Colour of aqueous dispersion
1 % CWS	gelatin dextrin sucrose	water-dispersible (10 - 20°C)	red orange
10 % CWS	gelatin sucrose	water-dispersible (10 - 20°C)	red orange
10 % WS	gelatin starch sucrose	water-dispersible (40 - 60°C)	red
pigment 10 %, type RVI	gelatin vegetable oil	water-dispersible (40 - 60°C)	pink to violet

TABLE 2 : STABILITY OF CANTHAXANTHIN (CXN) IN DANISH TYPE SALAMI

Assay	Theoretical CXN content (mg/kg dry basis)	CXN content (mg/kg dry basis) After chopping	After smoking	After drying	CXN loss %
1	-	-	-	-	-
2	57,8	50,0	53,0	56,0	3,1
3	118,0	100,0	99,0	107,0	9,3
4	117,0	104,0	105,0	109,0	6,8
5	113,0	95,0	113,0	113,0	0
6	157,0	142,0	136,0	165,0	4,1

TABLE 3 : STABILITY OF CANTHAXANTHIN (CXN) IN FRANKFURTERS

Canthaxanthin	Serial A ** Incorporation level (mg/kg)	Serial A ** CXN loss (%)	Serial B Incorporation level (mg/kg)	Serial B CXN loss (%)
10 % WS	150	0	120	2,7
			120*	0
10 % CWS	150	13,3		
	150*	3,0	120*	14,3
1 % CWS	1500	5,2	1200*	4,2
10 % RVI	150	15,4	180	2,0
	225	20,9	200	0
			300	1,9

* Incorporation in powder form
** Incorporation of colourants at the end of cuttering

TABLE 4 : STABILITY OF CANTHAXANTHIN (CXN) IN STRASBOURG SAUSAGES

Canthaxanthin	Serial A ** Incorporation level (mg/kg)	Serial A ** CXN loss (%)	Serial B Incorporation level (mg/kg)	Serial B CXN loss (%)
10 % WS	150	2,2		
10 % CWS	150	8,3	120	2,9
	150*	12,4		
1 % CWS	1500	9,6		
10 % RVI	150	23,9	120	1,3
	200	16,4	180	1,8

* Incorporation in powder form
** Incorporation of colourants at the end of cuttering

TABLE 5 : COLOUR APPRECIATION OF DANISH TYPE SALAMI (23 PERSONS)

Added colourant		Exp.	Incorporation level g/kg	Note : average interval of trust 1 2 3 4 5 6 7 8 9
Canthaxanthin pigment 10 %, type RVI		1	-	
		2	0,3	
		3	0,6	
		4	0,6 (liquid)	
		5	0,6	
		6	0,9	
Carmine	powder	7	0,2	
		8	0,3	
		9	0,3	
		10	0,4	
	liquid	11	3,6	
	salt	12	10,0	
Commercial samples				

TABLE 6 : COLOUR APPRECIATION OF CHORIZOS (14 PERSONS)

Added colourant		Exp.	Incorporation level g/kg	Note : average interval of trust 1 2 3 4 5 6 7 8 9
-		1	-	
Carmine (powder)		2	0,05	
Canthaxanthin	10% WS	3	0,25	
		4	0,20	
	10% CWS	5	0,15	
		6	0,20	
Commercial samples				

FIGURE 1 : STRUCTURAL FORMULA OF CANTHAXANTHIN

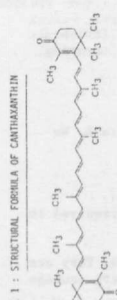

FIGURE 2 : CONFIGURATION OF CIELAB SPACE

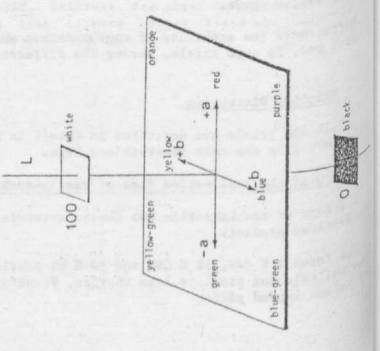

FIGURE 3 : AVERAGE a AND b VALUES FOR 11 FRANKFURTERS SAMPLES

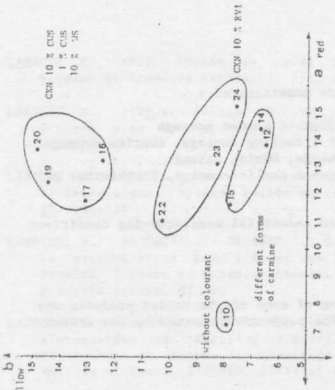

FIGURE 4 : COLOUR EVOLUTION OF DANISH TYPE SALAMI
COLOUR MEASUREMENT : AFTER CHOPPING (1), AFTER 2 DAYS (2), 7 DAYS (3), 58 DAYS (4) OF DRYING