The Influence of Ionising Radiation on Colour Change of Poultry Meat

Vesna Bulatovic, Jovanka Popov-Raljić and Natalija Džinić

CONCLUSIONS:

- The colour of poultry meat, as one of quality characteristics, was not significantly changed during freezing (-18°C) and subsequent storage till 180 days in neither group of samples (I and II).
- In both group of samples the value L^* was not significantly changed during storage till 180 day
- The value of a^* had the smaller variation between the group II
- The value of b^* show the smaller variation between group I and II on the 180^{th} day
- The instrumental measurements showed that the use of irradiation with doses up to the 4 kGy resulted in insignificant colour difference between samples packed under aerobic (I) and vacuum (II) conditions

BACKGROUND

The meat colour is the combination of visually understood informations contained in the light emitted or dissipated by the sample [Mac Dougall, 1988]. The muscle colour originates mostly on myoglobin (95%), and less on haemoglobin. The myoglobin content depends on a number of factors (feeding before slaughter, age, kind, muscular activity etc.).

The colour of food is the consequence of light absorption and reflection. The intensity of this selection depends on the physical appearance of food surface, structure, composition as well as presence of pigments. The selective absorption of light is the consequence of interaction of electromagnetic radiation in the range 400-700 nm and of outside valent electrons of certain atoms (in case of molecules - the electrons are from outside orbits)[Pribiš et all., 1993]. Having in mind that a lot of chemical bonds or atom groups can be colour carriers, and that numerous complexes which are capable of absorption in the visible part of the spectrum exist, it is obvious that food colour is a complex idea and that it is the consequence of constant and numerous enzymatic activities.

The sensory characteristics of food are very sensitive to ionising irradiation, especially when they are not so good before treatment.A popular standpoint is that a universal food preservation method is necessary for the application on a brod range of food. Since no preservation technic is universal applicable, the effect of ionising irradiation is also limited(Robins, 1991).

MATERIAL AND METHODS

Colour change of poultry meat (Arbor Acre bred, age 42 days) under the influence of freezing and combined treatment of freezing and ionising irradiation (technological doses - 2,3 and 4 kGy) was followed during 180 days. The samples were frozen and stored at -18°C.Two groups of samples were formed:

I - frozen, nonirradiated samples, stored at -18°C for 180 days,

II - frozen, irradiated samples, stored at -18°C till 180 days.

Both groups of samples were packed in two kinds of packaging:

1. Aerobic packaging – **A** 2. Vacuum packaging - **V**

Colour was determined and after freezing and storage till 180 days, every 90 days (I-A, I-V). The colour of samples II group was determined after the irradiation (0 day) as well as after storage at -18°C for 90 and 180 days.The colour of 1 cm thick, dry, flat cut of *muscullus illiotibialis* was determined using the MOM Colour D (Ungarische Optische Werke, Budapest). The additive mixing of colours is the principle of colour determination and the colour is defined by the following systems [Robertson, 1977]:

1 - CIELab (L*, a*, b*) - derived from the standard CIE system and defines the colour by the following values:

L* - psychometric light or colour lightness; **a*** - psychometric tone (portion of red and green colour) and **b*** - psychometric chrome (portion of yellow and blue colour).

RESULTS AND DISCUSSION

From the table 1 it can bee observed the parameters for colour definition in CIELab system in I and II group of samples.

Increase of colour angle till the 90th day was observed in aerobically packed samples (I – A). This means that the portion of red colour (a*) is lower and the lightness (L) is higher in these samples. From 90th to 180th day the colour angle decreased e.g. the red colour portion (a*) increases and in the same time the lightness (L) decreased. The change of red colour portion is probably the result of oxymyoglobin production. This form of myoglobin is expressively red. The nonirradiated samples, packed under aerobic conditions (I - A) after 180 days were lighter compared to the initial values. No regularity in red colour portion (a*) change was estimated during storage. In the first 90 days period the red colour portion decreased (from 15,43 - initial value to 4,88). The yellow colour portion (b*) remained constant during the whole storage period.

In the same non-irradiated group of samples, but packed under vacuum (I - V),the colour angle increased and a little increase of yellow portion (b*) was observed. During the 90-180 days period,the L* value confirms the mentioned statement, a* value decreased, while no significant difference in b* values were estimated compared to the initial level. The angle of colour was thus smaller and the colour moved to the red part of the spectrum.Comparing the portion of red and yellow colour in aerobically (A) and vacuum packed samples (V) a significant drop of red colour portion was noticed in A-samples till the 90th day. A similar increase of red colour portion (a*) was noticed in the period from 90 to 180 days.

The same table present the change of a* and b* values of aerobically packed samples exposed to combined treatment (freezing and irradiation, 2 kGy doses).The changes were such that they did not affect a significant change in aerobic packed samples.

In vacuum packed samples the yellow colour portion (b*) sharply decreased during the first 90 days of storage while the decrease of red colour portion (a*) was somewhat slower. In the same period, the brightness (L*) increased till 56,88 and remained

further approximately on the same level.

The table 1 show the change of main colour parameters in CIE Lab systems for aerobically packed samples, frozen and exposed to ionising irradiation (3 kGy - doses) (II - A). The change of parameters a* and b* during the 180 days storage period is relatively in accordance. In vacuum group of samples (II-V) till 90th day, a significant increase of a* values was noticed. In the same time, the yellow colour portion decreased slightly, so the colour portion was 1,18 and 1,12 on the 90th and 180th day, respectively. The colour angle decreased also, from initial 68,23 to 40,13 i.d. 41,66, e.g. the samples became darker.

The values obtained during measurement of parameters relevant for colour determination, for the group of samples frozen and irradiated with 4 kGy doses, are also presented in Table1. In aerobically packed samples a slight increase of parameters a* and L* was observed till 180th day of storage, while parameter b* remained unchanged. In vacuum packed samples the portion of red colour (a*) increased during the 90-180 days storage interval, while the brightness (L*) tended to decrease. L* values showed tendency of slight decrease.Till 90 days of storage, the red colour portion slightly increased, and the L* and b* values were in positive correlation.

The main factor which limits the use of vacuum packing in wholesale trade of cut meat is the discoloration as the consequence of metmyoglobin formation (due to residual oxygen in the packaging). Low oxygen concentrations (less than 1-4 mmHg) may be expected when the permeability of packaging is rather low. This oxygen concentration is enough for the maintaining of myoglobin in the reduced form [Renere, 1990).

However, higher oxygen concentrations (4-10 mmHg) (when the oxygen permeability is higher) results in oxidation of myoglobin to metmyoglobin which gives the meat the undesirable colour. When the partial pressure of oxygen in the packaging is 6,0-7,5 mmHg, the level of metmyoglobin is higher [Ledward,1970]. Colour reversion of meat is faster and more complete in meat packed in oxygen permeable packaging (aerobic packing), as oxidation of myoglobin to oxymyoglobin is needed to obtain the "red" colour of meat. However, when meat contains metmyoglobin, more time is necessary for the reversion of its "normal" colour, because first the metmyoglobin has to be converted to myoglobin by aerobic reductive activity of meat and than can start the oxidation to oxymyoglobin.

The advantage of vacuum packaging is the reduction of mass, the preservation of colour, elimination of external contamination and prolonged shelf life [Seideman,Durland,1983].

The nondesirable changes of sensory characteristics may be exceeded by irradiation in anaerobic conditions. The exclusion of oxygen from the packaging prevents the occurrence of off-odour and change of colour, formed by oxidation [Niemand et all., 1983].

References:

1.Mac Dougall D.B., 1988, Sensory Analisys of Foods, 2nd Edition, J.R. Piggot (Ed.) Elsevier Applied Science, London, **2**.Pribiš V., N.Šijaèki, Gy. Lukacs, 1993, □ivinarstvo, 7-9, 89-98, **3**.Robins D., 1991, The preservation of Food by Irradiation, London Press., **4**. Renere M., 1990, Int.J.Food Sci., 25, 613, **5**.Ledward D.A., 1970, J.Food Sci., 35, 33, **6**.Seideman S.C., P.R.Durland, 1983, Vacuum packaginig of fresh beef : a review., J.Food Qual., 6, 29

Table 1. The score of colour parametar after freezing (N) and combinated treatment (Z)

		AEROBIC CONDITION				VACUUM CONDITION			
		N	Z_{2kGy}	Z_{3kGy}	Z_{4kGy}	N	Z_{2kGy}	Z_{3kGy}	Z_{4kGy}
CIE Lab 0th-day	a*	15,43	9,15	10,50	7,77	7,53	2,22	4,28	4,81
	b*	10,44	12,12	13,10	9,83	13,04	11,60	11,05	11,05
	L*	43,69	45,78	47,10	47,37	44,61	46,64	47,36	51,14
	ΔCab	18,63	15,18	16,78	12,53	15,05	11,81	11,85	12,05
	ΔL	-48,55	-46,47	-45,15	-44,87	-47,62	-45,61	-44,89	-41,11
	ΔHab	9,21	7,40	7,87	6,78	6,97	5,11	5,72	5,89
	a*/b*	1,47	0,75	0,80	0,79	0,58	0,17	0,39	0,44
angle of colour	θ(°)	34,08	52,95	51,29	51,68	59,99	80,54	68,23	66,48
CIE Lab 90th day	a*	4,88	4,24	5,36	8,49	3,48	3,79	11,58	5,23
	b*	11,76	19,75	11,54	9,13	13,81	6,39	9,76	8,31
	L*	51,54	56,88	54,25	50,23	53,92	54,38	45,62	49,95
	ΔCab	12,73	20,20	12,72	12,47	14,24	7,43	15,14	9,82
	ΔL	-40,71	-35,37	-37,99	-42,01	-38,33	-37,87	-46,63	-42,30
	ΔHab	5,95	6,72	6,08	6,93	5,77	4,88	7,98	5,69
	a*/b*	0,41	0,21	0,46	0,93	0,25	0,59	1,18	0,63
angle of colour	θ(°)	67,46	77,88	65,09	47,08	75,86	59,33	40,13	57,82
CIE Lab 180th day	a*	9,96	8,11	9,44	10,54	9,35	28,60	9,51	9,67
	b*	10,00	12,22	12,87	10,96	11,60	11,06	8,46	9,56
	L*	49,52	50,46	52,43	51,79	48,53	52,57	47,26	47,24
	ΔCab	14,11	14,58	15,96	15,20	14,89	45,18	12,73	13,60
	ΔL	-42,82	-41,88	-39,81	-40,55	-43,80	-39,76	-45,08	-45,09
	ΔHab	8,82	8,20	8,75	9,08	8,74	15,14	8,67	8,78
	a*/b*	1,00	0,66	0,73	0,96	0,81	2,58	1,12	1,01
angle of colour	θ(°)	45,11	56,43	53,74	46,12	51,13	21,14	41,66	44,67

NOTES