J Food Sci Technol (May–June 2011) 48(3):378–381
DOI 10.1007/s13197-011-0308-1

SHORT COMMUNICATION

Evaluation of coloring efficacy of lac dye in comminuted meat product

Divya · R. P. Singh · B. Baboo · K. M. Prasad

Revised: 11 September 2010 / Accepted: 11 September 2010 / Published online: 6 February 2011

Abstract Effect of incorporation of graded levels (4, 6, 8, 10, 25 ppm) of lac dye on coloring efficacy and possible use of this natural color in processed meat products was studied. Inclusion of lac dye at different concentrations did not affect the pH significantly whereas a linear increase in the Lovibond red color unit of chicken nuggets was noted with raising the level of lac dye from 4 to 10 ppm. The sensory rating for color was highest at addition level of 25 ppm of lac dye and it was comparable to color score of the product containing 200 ppm sodium nitrite. Lac dye inclusion in nuggets at all concentrations studied had better antimicrobial properties as compared to 200 ppm sodium nitrite. It was concluded that lac dye from 10 to 25 ppm could be incorporated in comminuted meat products as a natural colorant with antimicrobial action.

Keywords Lac dye · Natural color · Chicken nuggets · Sensory quality · Microbiological quality

Appearance and color is an important factor influencing consumer's acceptability of the food including meat products. The characteristic pink color and antimicrobial properties of nitrite-treated meat products have a special role in consumer acceptance. However, the replacement of synthetic chemicals by natural colors as food additive has been receiving greater attention in recent years. There is, thus, a need for replacement of artificial dyes used in food industry with natural dyes because of several toxicants present in the artificial dyes and chemical like sodium nitrite making them undesirable for human consumption (Mazza and Miniati 1992; Youdim et al. 2000). Lac dye color is the natural edible food pigment extracted and refined from the resinoid lac. The resinoid is excreted by the female *Laccifer lacca* which parasitizes on certain specific trees like the *ber*, *palas* and *kusum*. It is brilliantly red color, acidic in nature and is a mixture of at least five closely related anthraquinone structures known as laccaic acid A, B, C, D and F. Lac dye is probably the most ancient natural dye. It is used from ancient time in textile and as a medicinal agent in the treatment of boils, burns and controlling blood flow after birth (Basu et al. 1996). Lac dye may be considered as a substitute of synthetic colorants owing to the bright and attractive colors. It is non-toxic to human health and used now-a-days as food coloring material (Chakravarty and Roy 1980; Chakravarty and Sreedhar 1980; Ghosh and Chakravarty 1982). This fact was supported in an experiment carried out at Industrial Toxicological Research Centre, Lucknow, India, to see acute and short term oral toxicity of lac dye in Albino rat (Anon 2004). The Food Additive Hygiene Standards of China has approved the use of lac dye as a coloring agent in fruit/vegetable drinks, carbonated drinks, blended wines, candies, fruit jams, condiments and sauces, with a maximum permissible dosage of 0.5 g/kg body weight (Anon 1996). With this in view, a study was conducted to evaluate coloring intensity, thermal stability and bactericidal properties of natural color derived from lac as an alternative to sodium nitrate/nitrite in emulsion-based chicken meat product.

Divya (✉) · B. Baboo · K. M. Prasad
Indian Institute of Natural Resins and Gums,
Ranchi 834 010, India
e-mail: dsdivyasharma714@gmail.com

R. P. Singh
Central Avian Research Institute,
Izatnager 243122, India

Extraction and purification of lac dye Lac dye was recovered from washed water, an effluent obtained during the processing of sticklac to seedlac from lac processing unit. The wash water when treated with 10% HCl, a solid precipitated out as sludge while a portion of dye remained in the solution. It was filtered and solid sludge was washed three times with hot water. Now the whole washings and filtrate were mixed and treated with lime to precipitate the lac dye as its calcium salt. It was filtered, washed and treated with mineral acid whereby lac dye was precipitated. The crude dye was filtered, washed, dried and further purified. It was suspended in water and then treated with sodium bicarbonate to just dissolve the dye and filtered. The clear filtrate was treated with 50% HCl in cold making it strongly acidic and then kept for a week. It was subsequently filtered and washed with cold water and dried. The dye was bright red in color. Its solubility in water was 0.13 g/ml water at 30 °C and completely soluble in DMF (Dimethyl formamide).

Preparation of chicken nugget Culled adult chicken were dressed conventionally and deboned manually. The deboned meat was minced twice in a meat grinder (WD114, Hobart, Germany), using 8 mm plate followed by 6 mm plate. This ground meat was used in the chicken nugget formulation. Formulation consisted of minced chicken meat 70%, refined vegetable oil 8%, refined wheat flour 5%, common salt 1.5%, spice mix. Two percent, condiments (garlic: ginger, 1:1 w/w) 3%, sodium tripoly-phosphate (STP) 0.5% and ice flakes 10%. The meat emulsion was made in bowl and chopper (4812, Hobart, Germany). Minced chicken meat, common salt and STP were added and chopped for 2 min. After addition of ice flakes, it was chopped again for 2 min. Refined vegetable oil was slowly added while chopping for proper dispersion. Condiment paste and refined wheat flour were added and chopping continued until a uniform and desired emulsion consistency was obtained. The meat emulsion (12.5 kg) so obtained was divided into 7 equal lots. Control group was devoid of either sodium nitrite or lac dye. Treatment, T-1 contained 200 ppm permitted level of sodium nitrite (Richard et al. 1992). Lac dye was added at 4, 6, 8, 10, 25 ppm in treatments T-2, T-3, T-4, T-5 and T-6, respectively. Meat emulsion was placed in aluminum moulds, packed compactly and covered. The emulsion filled moulds from all the treatments were cooked in a steam (1 kg/cm^2) bath for 10 min. The meat blocks were cooled at room temperature and cut into nuggets of $1.5 \times 1 \times 1$ cm size.

The pH of chicken meat nugget and emulsion was determined directly, using piercing glass electrode of the digital pH meter (Cyberxan2100, Eutech Instruments, Singapur). The color of emulsion and cooked chicken nugget was measured by Lovibond tintometer (Model –F, Salisbury, UK). The color readings were recorded after matching the sample color with the color slide of the instrument. The lowest color unit recorded was expressed as dullness. The next higher color unit was subtracted from the red unit to arrive at the net red color unit. Microbial (aerobic plate count, yeast and moulds) counts were done for emulsion and cooked nuggets stored at 5 °C for 24 h as per APHA (2001) methods. Three trail were conducted and all these measurements were done in duplicate samples, except objective color measurement in triplicates and data were analysis for standard deviation as per computerize excel programmed. Steam-cooked chicken nuggets were shallow fried for 1 min and served to five in-house, semi-trained sensory panelists to judge the appearance/ colour of the product on a 7-point descriptive scale ranging from 7 (extremely desirable) to 1 (extremely undesirable).

Results are presented in Table 1.

The effect of incorporation of natural lac color in different concentrations ranging from 4 ppm to 25 ppm in raw chicken nugget emulsions revealed no change in the emulsion pH and the same was also comparable to that of either control or synthetic chemical. The pH values between control and treated raw emulsion were 6.02 to 6.1 whereas an increase in the pH of the cooked nugget was recorded by 0.1 to 0.2 unit regardless of treatments. However, the difference in the pH among the sodium nitrite and lac colour groups was negligible. Chicken nuggets of control group containing neither nitrite nor natural lac colorant had a red color unit of 1.2 without any dullness which might be because of oxidized muscle myoglobin and residual hemoglobin. Incorporation of sodium nitrite at 200 ppm level raised the red color unit from 1.2 in control to 1.9 color unit in the treated group with 0.3 dullness unit. As expected, a linear increase in the Lovibond red color unit of the product was noted with raising the level of lac color from 4 to 10 ppm without any appreciable difference in the dullness unit. However, it is not clear why the redness unit was relatively lower in nuggets containing 25 ppm lac color as compared to formulation containing 10 ppm lac color. There was no study on meat by incorporating lac dye to compare the present result. However, it might be possible that at pH 6 the color of lac dye is red-violet and due to higher (25 ppm) concentration of this natural food color might have interacted somewhat differently with meat emulsion constituents as indicated by a slight decrease in redness unit with corresponding numerical increase in dullness. Chairat et al. (2004) reported a substantial bath-ochromic shift of the visible absorption band with increase in pH of lac dye. This assumption is supported by the fact that addition of lac color at 50 ppm level in chicken nugget

Table 1 Changes in quality of chicken nuggets containing sodium nitrate and natural lac color

Treatments	Control	T1	T2	T3	T4	T5	T6
pH (n=3)							
ME	6.0±0.11	6.0±0.00	6.1±0.10	6.0±0.0	6.0±0.00	6.1±0.00	6.1±0.00
CN	6.2±0.00	6.2±0.00	6.2±0.12	6.2±0.11	6.3±0.00	6.3±0.00	6.3±0.00
Loviband Tintometer unit (n=3)							
ME-R	0.8±0.10	0.1±0.05	0.4±0.11	0.5±0.0	0.5±0.05	0.6±0.10	1.9±0.15
ME-D	Nil	0.2±0.0	0.3±0.10	0.3±0.0	0.5±0.05	0.4±0.11	0.9±0.10
CN-R	1.2±0.02	1.9±0.11	1.3±0.11	1.5±0.11	1.8±0.10	2.0±0.30	1.7±0.15
CN-D	Nil	0.3±0.0	0.3±0.17	0.3±0.05	0.5±0.10	0.4±0.10	0.6±0.05
Aerobic plate counts, log cfu / g (n=3)							
ME	6.0±0.03	6.0±0.05	5.4±0.03	5.4±0.08	5.3±0.09	5.0±0.04	4.9±0.08
CN	4.8±0.02	4.6±0.10	4.2±0.02	4.1±0.10	4.1±0.04	4.0±0.05	3.5±0.06
Yeast and mould counts, log cfu /g (n=3)							
ME	3.2±0.02	3.0±0.02	3.0±0.02	2.9±0.02	2.9±0.08	2.8±0.06	1.5±0.06
CN	2.2±0.10	2.0±0.02	1.9±0.10	1.9±0.08	1.7±0.11	1.7±0.09	1.0±0.00
Sensory score for colour (n=5 panelists)							
CN	3.8±2.28	6.0±0.70	4.0±2.00	5.0±1.22	3.6±1.14	3.6±0.08	6.0±0.70

Control: without sodium nitrate and lac colour, T1: with 200 ppm sodium nitrate, T2-T6 : with 4, 6, 8, 10, 25 ppm natural lac colour, respectively

ME Meat emulsion, *CN* Cooked nuggets, *R* Redness, *D* Dullness

meat emulsion (data not shown) produced highly undesirable violet coloration of the product and, thus, the product became totally unacceptable as far as its appearance to visual appeal is concerned. Hence, this treatment group was excluded from objective color measurement by the Lovibond tintometer. On cooking in all treatments color of cooked nugget increased with increased level of lac dye. Sodium nitrite at 200 ppm also produced higher color intensity on cooking as compared to raw emulsion which is agreement of findings reported by Adamsen et al. (2006) and Honikel (2008). Control group devoid of any added food color has the least score for colors. Sensory panelists were unable to distinctly differentiate the degree of coloration of the product containing graded level of lac color from 4 to 10 ppm but rated the formulation containing 25 ppm lac color at par with the intensity of redness produced by 200 ppm sodium nitrite in communicated meat as evident from similar mean scores for color between these two treatments. Objective color measurement by Lovibond tintometer also showed redness unit (1.9) by 200 ppm sodium nitrite falling between that of 10 and 25 ppm lac color.

No appreciable difference in the total aerobic mesophilic bacterial counts was found in meat emulsion between control and synthetic chemical at 200 ppm sodium nitrite. On the other hand, a noticeable decrease in mesophilic bacterial count was observed in meat emulsion containing lac dye ranging from 4 to 25 ppm. These results indicated that lac color even at lowest level (4 ppm) has shown better antimicrobial property in comparison to sodium nitrite (200 ppm) incorporation to either meat emulsion or its effect in cooked product prepared. The antibacterial effect of nitrite is due to prevention of growth of bacteria rather than direct killing (Ockerman 1983; Cassens 1995). The initial yeast and mould count in raw chicken meat emulsion was log 3.2 cfu/g which reached to log 3.0 in emulsion containing 200 ppm sodium nitrite. On the other hand, almost a dose-dependent decrease in the fungal counts was observed in raw emulsion samples containing natural lac color in concentration ranging from 4 to 25 ppm. Like raw emulsion, the fungal counts in cooked nugget samples containing graded levels of natural lac colour also appeared to be dose dependent. These results indicated that lac color in any of the concentrations used in this experiment exhibited greater anti-fungal activity than synthetic food chemical *viz*. 200 ppm sodium nitrite commonly used in meat products. Lac dye has bactericidal (Basu et al. 1996) and fungicidal properties whereas nitrite functions as bacteriostatic (Ockerman 1983; Cassens 1995).

The addition of lac dye from 10 to 20 ppm in chicken meat emulsion improved the meat product color and scored almost equal to the redness values produced by permitted level of 200 ppm sodium nitrite. It also showed better anti-microbiological properties in any concentration used in comparison to synthetic color, sodium nitrite. Thus, natural lac dye at 25 ppm can be effectively used as an alternative to synthetic color in chicken nuggets.

References

Adamsen CI, Mollen JKS, Laursen K, Olsen K, Skibsted LH (2006) Zinc-porphyrin formation in cured meat products: effect of added salt and nitrite. Meat Sci 72:672–679

Anon (1996) Lac Dye Red 1996 (Code No. 8.104) ICS 67.220.20 GB, National Standard of the People's Republic of China, GB 2760

Anon (2004) Final report: acute and short term oral toxicity of lac dye in Albino rats. Industrial Toxicological Research Centre, Lucknow

APHA (2001) Compendium of methods for the microbiological examination of foods, 4th edn. American Public Health Association, Washington DC

Basu SP, Haq AA, Chaudhuri SK (1996) Preliminary study on the antibacterial activity of lac dye. Proc Nat Seminor, Lac Industry-Challenges and Solution, 14–15 June, 1996 ILRI, Ranchi, Bihar, India, pp 109–112

Chairat M, Rattanaphani V, Bremner JB, Rattanaphani S, Perkins DF (2004) An absorption investigation of the interaction of lac dye with metal ions. Dye Pigment 63(2):141–150

Chakravarty I, Roy BR (1980) Evaluation of lac dye as a possible food color: studies on hepatic biochemistry. Indian J Publ Health 24:170–175

Chakravarty I, Sreedhar R (1980) Effect of lac dye on transaminase. Ind J Nutr Dietet 17:377–381

Cassens RG (1995) Use of sodium nitrite in cured meats today. Food Technol 49(7):72–80

Ghosh A, Chakravarty I (1982) An experiment study to evaluate any possible interaction of lac dye with the hepatic tissue. Ind J Nutr Dietet 19:310–316

Honikel K (2008) The use and control of nitrate and nitrite for the processing of meat product. Meat Sci 78:68–76

Mazza G, Miniati DP (1992) Copigmentation and self-association of anthocyanins in food model systems. Ital J Food Sci Pinerolo 4 (2):109–116

Ockerman HW (1983) Chemistry of meat tissue, Dept of Animal Science, Columbus OH 43210. The Ohio State University, USA

Richard JE, Addis PB, Warthesen JJ (1992) AG-FS-0974, Minne- sota Extention Service. University of Minnesota, USA

Youdim KA, Martin A, Joseph JA (2000) Incorporation of elderberry anthocyanins by endothelial cells increases protection against oxidative stress. Free Radic Biol Med (Washington) 29(1):51–60