International Food Research Journal 22(4): 1424-1428 (2015)
Journal homepage: *http://www.ifrj.upm.edu.my*

Practice of using metanil yellow as food colour to process food in unorganized sector of West Bengal - A case study

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Article history

Received: 13 June 2014
Received in revised form: 9 January 2015
Accepted: 12 January 2015

Keywords

Metanil yellow
Turmeric powder
Ladoo
Besan
Food adulteration

Abstract

We report here about the practice of using metanil yellow, a non permitted synthetic dye, in the adulteration of some food items produced by the organized and unorganized sectors located in different districts in West Bengal, India. We considered three food items- turmeric powder, ladoo and besan for the detection of the presence of metanil yellow. We observed that 58 of the 253 samples i.e. 20.94% of total samples contain metanil yellow in which 36.21% of the positive samples contained the metanil yellow below the maximum permissible limit i.e., below the 100 mg kg^{-1} food samples and 63.79% of the positive samples contained above the maximum permissible limit i.e., above the 100 mg kg^{-1} food samples as specified in the Prevention of Food Adulteration Act of India (PFA, 2008). We observed insignificant presence of metanil yellow in besan samples. We did not observe significant presence of metanil yellow in the same food samples collected from the organized sectors. We also found that all the positive samples i.e., the samples containing significant amount of metanil yellow were prepared from the food items collected from the unorganized sectors. From the study it is concluded that the unorganized sectors practice to use metanil yellow indiscriminately to adulterate the food items. We suggest strict governmental vigilance to prevent food adulteration with metanil yellow to avoid human health hazards.

Introduction

Some organized and unorganized sectors in West Bengal state of India are engaged in food processing activities. Interestingly, the unorganized sectors have flourished more rapidly than the organized sectors with the increase in demands of cheap available foods due to unprecedented population growth in West Bengal since the last few decades. It has been studied that both the organized and unorganized sectors use different kinds of synthetic colours to process some food items like ladoo, besan, orange or yellow colored sweets (amrity), ice cream etc. and spices mainly turmeric powder. Majority of synthetic food colours are highly toxic synthetic chemicals and banned by the central and state administration. The organized sectors generally follow the permissible limits as stated in rules and regulations regarding the use of food colours to process the food items. Moreover, their products go through regular quality checks by the quality control laboratory before the marketing. Therefore, most of the food items prepared by the organized sectors get the necessary quality control certification from the state administrative desk due to the presence of very negligible amount of food colour. On the other hand, due to lack of adequate infrastructures and governmental control, the unorganized sectors do not follow the permissible limit of the intended dye to process the foods and spices with the said colour. In most of the cases excessive amounts of food colours are used to bring the intended colour of the processed food to attract people ignoring the safe limit of food colours for use. Therefore, the use of food items and spices processed by unorganized sectors for marketing are very risky to use if we considered the human health hazards. The unorganized sectors predominantly use cheap synthetic food colours to process food and spices which are not fit for human consumption, and specified for industrial use only. The most common industrial colour used by the unorganized sectors is metanil yellow. Metanil yellow has been considered as one of the potent toxic chemicals due to its severe toxicity in some organ systems in animals.

Metanil yellow is a banned dye as per PFA Act (1954), by Government of India, because the same dye has found to be carcinogenic in human. According to the Food Safety and Standard Authority of India permit the use of 8 synthetic colours in specified food commodities (PFA, 2008). The maximum limit of permissible colours to be added in any food shall be 100 mg kg^{-1} or $litre^{-1}$ of food as consumed (Dixit

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et al., 2011). A report on carcinogenesis (Combes *et al*., 1982) stated that the metabolism of azo dyes derived from benzidine converted to aromatic amines by intestinal bacteria is potentially carcinogenic. According to a report recently published in Current Sciences, some synthetic dyes like auramine, metanil yellow, lead chromate, rohdamine, sudan-3 and 4, orange-2 and malachite green cause serious health hazards being mutagenic and potentially carcinogenic (Dees *et al.*, 1997). Metanil yellow, the most frequently used non-permitted food colour widely used in food items, like "ladoos", causes insufficient oxygen supply to skin and mucous membranes along with degenerative changes in the stomach, liver, kidney, abdomen and testes and also found to cause cyanosis (Chandra *et al*., 1987). It was also found to cause toxic methaemoglobinaemia in adult human males 2-4 hours after the consumption of rice coloured with it (Dees *et al*., 1997).

Few reports conducted by scientists in different times have revealed the fact that metanil yellow finds wide application in variety of yellow/ orange coloured foods in both cities and rural areas (Khanna *et al*., 1985; Khanna *et al.*, 1987). We did not find any report till date about the presence of metanil yellow in different food items found in the provincial market in our state, West Bengal. In West Bengal, majority of the common people use food items and spices available local market coloured with synthetic food dye produced by unorganized sectors. Therefore, the present study was undertaken to detect the presence of metanil yellow as food colour in some selected food items produced by both organized and unorganized sectors; and also to determine the amount of metanil yellow present in each food item, if the presence of metanil yellow is detected.

Materials and Methods

Food samples collected for testing the presence of metanil yellow

We have collected 253 food samples consisting of three different types of food items- turmeric powder, ladoo and besan for testing the presence of metanil yellow. From each place, 100 grams of turmeric powder, two pieces of ladoo each having a weight of 50-60 grams, and 100 grams of besan have been collected.

Areas selected for the collection of food items

Collection stations in each district were chosen from downtown to country site areas considering the distribution of populations living in different financial stratums. In West Bengal, middle class people live in the downtown or town areas and lower class or lower middle class people live in rural belts. Therefore, to get a true picture about the adulteration of food or food items with metanil yellow, zones have been selected considering the economic profile of the people. Areas from which samples are collected are given in the table1.

Apparatus and chemicals

A systronics 118 single beem UV-VIS spectrophotometer with 1.0 cm quartz cell was used for measurement of absorbance. All the weights were taken on Citigen CY 120 electronic balance [Sl. No. 9061515]. Analytical grade metanil yellow was procured from Sigma-Aldrich company and hydrochloric acid was procured from Merck Specialties Private Limited was used for the preparation of standard curve and quantitative estimation of metanil yellow in food samples.

Preparation of standard solution and regression curve

At first a stock solution was prepared with a concentration of 100 µg mL^{-1} of metanil yellow and then a series of standard solutions were prepared (ten different concentrations of metanil yellow were prepared: 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 µg mL^{-1}). Each standard solution was added with 50 µl of 1 (N) HCl and allowed to stand for at least 5 minutes for the development of pink colour. Then the absorbance was measured at 450 nm against a reagent blank prepared concurrently (Nath *et al.*, 2013).

Preparation of sample solution

A total of 253 samples were prepared from three different food items. To prepare a sample solution, 1 gm of each food samples was taken in a beaker and dissolved in 10 ml of distilled water. After homogeneous mixing, the solution was filtered by passing through a Whatman filter paper placed on a glass funnel fitted with a conical flask. After that, 0.5 ml of filtrate obtained in the conical flask was taken in a test tube and volume was made up to 3 ml by adding distilled water. 50 µl of 1 (N) HCl was added to the solution to develop specific pink color of the solution. The optical density of the solution was then obtained with systronics 118 single beem UV-VIS spectrophotometer. The concentration of metanil yellow present in the sample solution was then calculated from the equation obtained from the standard curve by plotting the value of optical density (Nath *et al.*, 2013).

Table 1. The areas from where the samples were collected

Sl. No.	District Names	Areas/ Cites/ Villages/ Metropolitans
1.	Nadia	Kalyani, Payradanga, Kaliganj, Bethuadahari, Plassey, Krishnagar, Chakdaha, Nabadwip, Ranaghat
2.	Murshidabad	Khagra, Jalangi, Kandi, Lalbagh, Lalgola, Domkol
3.	Kolkata	Shyambazar, Rabindra Sadan, Park Circus, Kalighat, Jadavpur
4.	Midnapur (East)	Panskura, Tamluk, Mecheda, Bhagabanpur, Egra
5.	North 24 Parganas	Kanchrapara, Naihati, Barrackpur, Halisahar, Khardaha
6.	Howrah	Amta, Sankrail, Andal, Uluberia, Salakia

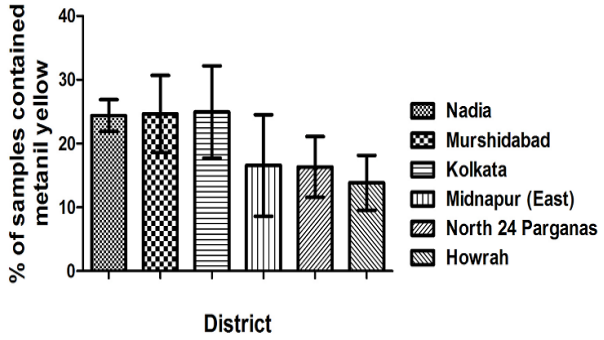

Figure1. Graphical representation of percentage of samples contained metanil yellow in selected areas of different districts in West Bengal, India.

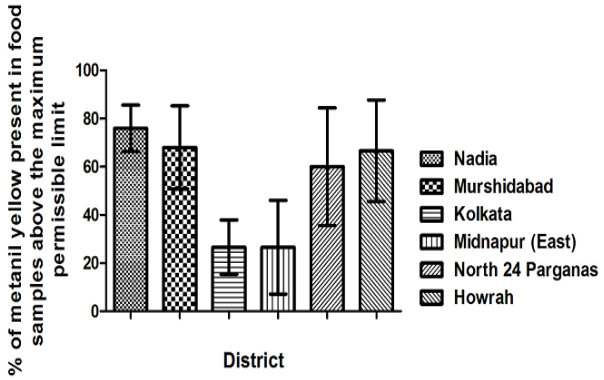

Figure 2. Graphical representation of percentage of positive samples containing the metanil yellow above maximum permissible limit out of the total positive samples obtained from selected areas of different districts in West Bengal, India.

Results

We have examined 253 food samples of three different food products- turmeric powder, ladoo and besan collected from six different districts of West Bengal to determine the percentage of metanil yellow, the non permitted food colour present in different food products. We got 58 positive samples out of total 253 samples analyzed [i.e., the 20.94% of the total samples (Table 2)] contained the metanil yellow as food colour (Figure 1). Out of the total positive samples (58 samples), we found 32.95% of the turmeric powder and 31.32% of the ladoo samples contained the metanil yellow (Table 3). We did not find significant contamination of metanil yellow in besan samples. Further, we found 36.21% of the positive samples contained the metanil yellow below the maximum permissible limit i.e., below the 100 mg kg^{-1} food samples and 63.79% of the positive samples contained above the maximum permissible limit i.e. above the 100 mg kg^{-1} food samples as specified in the Prevention of Food Adulteration Act of India (PFA, 2008) (Figure 2; Table 3).

Table 2. Showing district wise distribution of number of samples analyzed, metanil yellow found out of total sample analyzed and percentage of samples contained the matanil yellow in West Bengal

Names of districts	Total no. of samples analyzed	No. of samples contained metanil yellow out of total sample analyzed	% of samples contained metanil yellow
Nadia	86	21	24.41
Murshidabad	48	12	25.00
Kolkata	26	8	30.76
Midnapur (East)	25	5	20.00
North 24 Parganas	32	6	18.75
Howrah	36	6	16.66
Total	**253**	**58**	**20.94**

Discussion

It has been seen that 20.94% of the total samples contained the metanil yellow in a significant amount. Surprisingly, the food samples prepared from food products of unorganized sectors showed the positive results. Turmeric powder and ladoo were the most prominent metanil yellow adulterated food items made by the unorganized sectors. Further, 63.79% and 36.21% of the positive samples showed the contamination of metanil yellow above the maximum permissible limit and below the maximum permissible limit respectively. We did not find the presence of metanil yellow in any food samples prepared from the food items (turmeric powder, ladoo and besan) produced by the organized sectors.

It is an instinct phenomenon that humans are always attracted to food and drinks bearing pleasant colours. Additions of attractive colours can definitely enhance the appetizing value and the palatability of food and drinks for the consumers. So, from the manufacturer's point of view, colour is very much effective to increase the selling of food products. In West Bengal, both the organized and unorganized sectors are engaged in food processing activities. The unorganized sector has flourished more rapidly than organized sectors with increase in population in India including in West Bengal. Both organized and unorganized sectors are using different kinds of food colours, which are mainly synthetic in nature.

Table 3. Showing district wise distribution of metanil yellow containing food samples (positive samples) on the basis of the type of food selected for testing (column a, b and c); distributions of positive samples on the basis of maximum permissible limit of metanil yellow as specified in the Prevention of Food Adulteration Act of India (PFA, 2008); and percentage of positive samples containing the metanil yellow above the maximum permissible limit out of the total positive samples obtained

Names of districts	Total no. of samples analyzed	No. of samples contained metanil yellow out of total sample analyzed	Types of food items			Amount of metanil yellow present		% of MY present in food samples above 100 mg kg^{-1}
			Turmeric powder (a)	Ladoo (b)	Besan (c)	< 100 mg kg^{-1*} (Below the permissible limit)	>100 mg kg^{-1} (Above the permissible limit)	
Nadia	86	21	10	10	1	6	15	71.42
Murshidabad	48	12	8	3	1	4	8	66.66
Kolkata	26	8	3	5	-	5	3	37.50
Midnapur (East)	25	5	2	2	1	3	2	40.00
North 24 Parganas	32	6	3	3	-	1	5	83.33
Howrah	36	6	3	3	-	2	4	66.66
Total	**253**	**58**	**29**	**26**	**3**	**21**	**37**	**63.79**
Percentage		**20.94**	**32.95**	**31.32**		**36.21**	**63.79**	

*Maximum permissible limit of food colors at 100 mg kg^{-1} or $litre^{-1}$ of food preparation under the prevention of Food Adulteration Act of India (PFA, 2008)

Majority of synthetic food colours are highly toxic synthetic chemicals and banned by the central and state administration. But till date, the excessive use of metanil yellow is a common practice in unorganized sectors.

Our result depicts that unorganized food processing sectors in West Bengal indiscriminately use the metanil yellow, the banned cheap synthetic dye, to adulterate the food items like turmeric powder, ladoo and besan etc. to promote the marketing of those food items in rural districts ignoring the possible toxic effects of metanil yellow on human health. This may be due to lack of administrative supervision about the adulterant induced human health hazards as provided in the Prevention of Food Adulteration Act of India (PFA, 2008). We also observed variations in the amount of metanil yellow in the samples which contained the food colour above the maximum permissible limit. This might be due to lack of adequate infrastructure and trained staff in the unorganized sectors dealing with use of food colour in food products with adherence of the appropriate prescription as contained in the Prevention of Food Adulteration Act of India (PFA, 2008). On the other hand the organized sectors followed the permissible limits of metanil yellow as stated in the rules for using the food colour to process the food items. Besides, the organized sectors must go through quality control process before the marketing. We did not observed any significant presence of metanil yellow in food samples collected from the organized sectors. So, our result is supported by the fact as stated in the above.

Metanil yellow is an established food toxicant. From the literature we found that a variety of food were usually adulterated with non permitted colours such as auramine, rhodamine B, congored, orangeII, melachite green and metanil yellow (Ramesh *et al*., 1998; Ragini, 2004). Some information about the metanil yellow induced health hazards have been reported discriminately in animal models (Khanna and Das, 1991; Nagaraja *et al.*, 1993; Singh, 1996; Singh, 1998; Gupta *et al*., 2003; Sarker *et al*., 2012). We have examining the probable toxic effects of metanil yellow on female reproductive system in rat model. We have seen that metanil yellow altered the reproductive cycle in female rat and also altered the hormonal levels significantly (unpublished data). So, in order to avoid the deleterious toxic effects in human physiological functions the use of metanil yellow should be stopped immediately. Otherwise, the people belonging to lower economic stratum will be worst sufferer as a result of the consumption of metanil yellow-laden food items. We suggest that the state and district administrations should intervene and supervise the processing of food with metanil yellow as per Prevention of Food Adulteration Act of India (PFA, 2008).

Conclusion

The food products like turmeric powder, ladoo and besan processed by the unorganized sectors and marketed in the rural areas in West Bengal mostly contained the metanil yellow above the maximum permissible limits as provided in the Prevention of Food Adulteration Act of India (PFA, 2008). This might be due to indiscriminate use of metanil yellow in the food processing of unorganized sectors due to lack of governmental control and inadequate infrastructures. We suggest strict vigilance of the

appropriate administrative desk of the government and implementation of the law in this regard.

Acknowledgments

The author Partha Pratim Nath is grateful to the Department of Science & Technology, Ministry of Science & Technology, Government of India for financial assistance in the form of an award of Senior Research Fellowship (No. DST/INSPIRE FELLOWSHIP/2012/119) and also thanks to the Department of Physiology, University of Kalyani authorities for providing the necessary facilities in this work.

References

Chandra, S. S. and Nagaraja, T. 1987. A food poisoning outbreak with chemical dye–an investigation report. Medical Journal Armed Forces India 43: 291–293.

Combes, R. D. and Haveland-Smith, R. B. 1982. A review of the genotoxicity of food, drug and cosmetic colors and other azo, triphenylmethane and xanthene dyes. Mutation Research 98: 101–248.

Dees, C., Askari, M., Garrett, S., Gehrs, K., Henley, D. and Ardies, C. M. 1997. Estrogenic and DNA-damaging activity of Red No.3 in human breast cancer cells. Environmental Health Perspectives 105 (3): 625-632.

Dixit, S., Purshottam, S. K., Khanna, S. K. and Das, M. 2011. Usage pattern of synthetic food colours in different states if India and exposure assessment through commodities preferentially consumed by children. Food Additives & Contaminants. Part A, Chemistry, Analysis, Control, Exposure & Risk Assessment 28 (8): 996- 1005.

Gupta, S., Sundarrajan, M. and Rao, K. V. K. 2003. Tumor promotion by metanil yellow and malachite green during rat hepatocarcinogenesis is associated with dysregulated expression of cell cycle regulatory proteins. Teratogenesis, Carcinogenesis, and Mutagenesis 1: 301–312.

Khanna, S. K. and Das, M. 1991. Toxicity, carcinogenic potential and clinical epidemiological studies on dyes and dyes intermediates. Journal of Scientific and Industrial Research 50: 964-974.

Khanna, S. K., Singh, G. B. and Dixit, A. K. 1985. Use of synthetic dye in eatable in rural areas. Journal of Food Science and Technology 22: 269-273.

Khanna, S. K., Singh, G. B. and Singh, S. B. 1987. Non-permitted colours in food and their toxicity. Journal of Food Science and Technology 10: 33-36.

Nagaraja, T. N. and Desiraju, T. 1993. Effects of chronic consumption of metanil yellow by developing and adult rats on brain regional levels of nor adrenaline, dopamine and serotonin, on acetylcholinesterase activity and on operant conditioning. Food and Chemical Toxicology 31(1): 41-44.

Nath, P. P., Sarkar, K., Tarafder, P. and Paul, G. 2013. Development of a spectrophotometric method for the quantitative determination of metanil yellow in different food samples. International Journal of Pharma and Bio Sciences 4(2): 685-692.

Sarkar, R. and Ghosh, A. R. 2010. Metanil Yellow, a food additive, induces the responses at cellular and sub-cellular organisations of stomach, intestine, liver, and kidney of *Heteropneustes fossilis* (Bloch). Pollution Research 29(3): 453-460.

Singh, R. L. 1996. Effect of protein malnutrition on biochemical parameters of serum and liver of Metanil Yellow exposed rats. Environmental Toxicology and Chemistry 54(4): 107-113.

Singh, R. L. 1998. Effect of protein malnutrition on sex organs of metanil yellow exposed male rats. Biomedical and Environmental Sciences 11(3): 233-242.