

Effect of Different Concentration of Whole Yellow Mustard on Color of Commercial Tomato Ketchup

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Abstract: Ketchup is one of most important of tomato products. To increase the consistency, some hydrocolloid such as Carboxy Methyl Cellulose (CMC) should be added into the final products. However, CMC is a chemical product and has been shown some defects in point of health view as well as functional properties. Therefore, some alternatives are introduced. In this study, the effect of different concentration whole Yellow mustard on color of ketchup has been considered. The control was modified with increasing the different concentration of yellow mustard. For each sample, the color parameters in CIELAB color space were determined. The results were compared with the control sample which includes nothing of mustard. Results have shown for a concentration of 1.5% of yellow mustard the color properties of the product didn't differ very much from the standard color quality. This is an important point to replace CMC by yellow mustard.

Keywords: CMC, color properties, ketchup, yellow mustard

INTRODUCTION

Tomato ketchup is a product made of the concentrated extract out of fresh, healthy and ripe red tomato which is pilled and of no seeds; or the diluted tomato extract seasoned by spices and provided under pasteurization process, adding stabilizers (ISIR, 2006). Averagely out of 70 million tons tomato annual crops, 25-30 million tons are being processed (U.S. Nutrition Information, 2007). Good quality ketchup is judged by flavour, consistency, uniformity and attractiveness of color (Sharoba *et al.*, 2005). Color of ketchup is such an important factor that allows this food product a big variety in accordance with international standards. Food standard states if the products preserve fresh tomato natural color, devoid of any color additives and no color change while packaging and preservation, it is rated as a good product; but with color additives the product possesses a rather good standard (Caricom, 2010; Kenya Standard 2005). The main factor in ketchup color is lycopene available in tomato which is the carotenoidal pigment including 12 double conjugated bonds formed while tomato ripened and chlorophyll decayed. Among effective factors in ketchup color, tomato variety, the amount of salt and sugar used in formulation, the exposure of product to

oxygen, processing conditions and color combinations used in formulation is above all (De Stefani *et al.*, 2000). Viscosity seems another important factor whose increase requires a variety of hydrocolloids. Carboxyl Methyl Cellulose (CMC) is one of the known hydrocolloid in food industry but studies showed that this additive has not only an effective control over syneresis (Sahin and Ozdemir, 2007) and but also threatens man's health in high concentration (Sheftel, 2001). Therefore it is necessary to find any other substance to replace CMC in products in order not to have the abovementioned defects. Mucilage available in yellow mustard skin as linear hydrocolloids can increase viscosity and also result in improving product quality in food system. We can also benefit from other studies in this regard in the world, for instance Cui (1997) confirmed yellow mustard mucilage can help the context grow, raise stability and decrease syneresis, which resembles to xanthan gum in qualities (Cui *et al.*, 1993). According to previous observations by Yousefi *et al.* (2010a, b), mustard can be a suitable replacement for CMC. However mustard is yellow and can create changes in the color of final product, directly altering its quality and marketability, which is worthy reconsidering. A lot of different brands and types of catsup are available in the market, leading to a strong

competition between producers. Therefore, the manufacturers are obliged to provide products with a high quality. Sensory characteristics show a major influence on the consumer's choice and, considering quality attributes on purchasing, visual impression becomes the most relevant one. In this context, color is a very important indicator of quality, resulting in derived perceptions of visual expectation. It has been shown for a number of foods that color significantly affects the perception of flavor attributes or texture sensations. Certainly, the majority of the consumers will describe the color of tomato catsup just as red but, subconsciously, the color may serve as a major distinction parameter between competing products, leading to the question which one is preferred by the consumer. However little information is available on color preferences for tomato catsup.

In this view the purpose of this study was to investigate the effect of different yellow mustard concentrations (of the following percentages 0, 0/3, 0/5, 0/7, 0/9, 1/1, 1/3 and 1/5) are applied for the purpose of CMC replacement and the change of color has been assessed by spectrophotometer reflexive testing.

MATERIALS AND METHODS

Materials: Tomato paste produced by Dashte neshat, an Iranian food company with BX = 36. CMC acid resistant were purchased from Sunrose® a Japanese company, Yellow mustard powder from G.S.DUNN, a Canadian company, coded 601, Starch modified produced by Emsland, a German company.

Ketchup samples production methods: This study was conducted in Institute of Paint Industry of Iran on 9 ketchup samples with different mustard concentration percentages (0, 0.3, 0.5, 0.7, 1.1, 1.3, 1.5) in two groups, that is, CMC samples and non-CMC samples following the proposed formulation in Table 1 and 2 were produced and homogenized in 90°C with 200 bar pressure from January 2009 to January 2010.

Then to pasteurize, samples were being kept in boiling temperature for 15 min and finally packed in glassed jar under about 90°C (Cupka, 2007).

Color test: In order to investigate the efficacy of different concentrations of mustard on color of the produced samples, the reflexive testing spectrophotometer (color-eye 7000 A) (Gretage Macbeth Company) were used. Reflection of samples in wave length domains of 400 to 700 nanometers (Fig. 1) was measured. Then color factors of samples were calculated by the aid of Eq. (1), (2) and (3):

$$L^* = 116 (Y / Y_n)^{1/3} - 16 \quad (1)$$

Table 1: The first group of ketchup formulation

Ingredient	Mustard 0% +	Mustard 0.1% +	Mustard 0.3% +
	CMC 0.5%	CMC 0.4%	CMC 0.2%
Tomato paste	434	434	434
Sugar	260	260	260
Vinegar	190	190	190
Corn syrup	150	150	150
salt	29.4	29.4	29.4
Modified starch	26	26	26
Ketchup flavoring	5	5	5
CMC ¹	10	8	4
Mustard	0	2	6
Water	895.6	895.6	895.6

¹: Carboxymethyl cellulose

Table 2: The second group of ketchup formulation

Ingredient	Mustard					
	50%.	0.7%	0.9%	1.1%	1.3%	1.5%
Tomato paste	434	434	434	434	434	434
Sugar	260	260	260	260	260	260
Vinegar	190	190	190	190	190	190
Corn syrup	150	150	150	150	150	150
Salt	29.4	29.4	29.4	29.4	29.4	29.4
Modified starch	26	26	26	26	26	26
ketchup flavoring	5	5	5	5	5	5
Mustard	10	14	18	22	26	30
Water	895.6	891.6	887.6	883.6	879.6	875.6

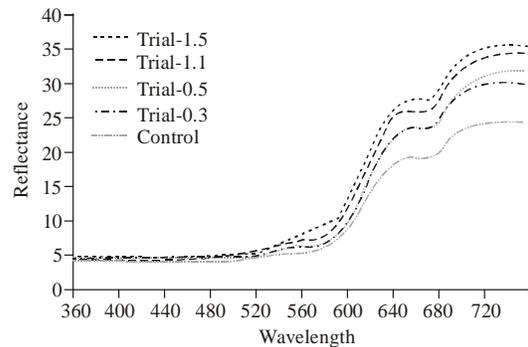


Fig.1: Reflectance spectra of selected catsup samples

$$a^* = 500 [(X / X_n)^{1/3} - (Y / Y_n)^{1/3}] \quad (2)$$

$$b^* = 200 [(Y / Y_n)^{1/3} - (Z / Z_n)^{1/3}] \quad (3)$$

In the Eq. (1), (2) and (3) amounts of x_n, y_n, z_n are the triple factors of standard lightness and amount of x, y, z are triples factors of substance in CIE color space. The color factors of CIELAB color space, that is, L^*, a^* and b^* are calculated under lightness of D_{65} and visual angle of 10. To calculate the amount of color difference, the following equation was used:

$$\Delta E_{ab}^* = (\Delta L^{*2} + \Delta b^{*2} + \Delta a^{*2})^{1/2} \quad (4)$$

Moreover, for more precise evaluation of sample color changes in the presence of yellow mustard different

amounts, angle of hue (h°) and color purity(c) were calculated:

$$h^\circ = \text{Arctg} (a^*/b^*) \quad (5)$$

$$c^* = (a^{*2} + b^{*2})^{1/2} \quad (6)$$

In (5) and (6), the (L^*) indicates the lightness of samples which is between 0 (ideal black) to 100 (ideal white). (a^*) shows redness and greenness of samples and finally (b^*) pictures yellowness and blueness of samples. Positive quantities for (a^*) and (b^*) report one redness and one yellowness respectively; but negative quantities report one greenness and one blueness. There has been no definite limit for (ΔE_{ab}).

It is obvious that 0 for the factor mentioned (ΔE_{ab}) proves the existence of color difference and the bigger this amount; the more increased the color difference. Following the ordinary experiences, such $\Delta E_{ab}^* < 1$ illustrates the appropriate limit. This could change according to the value of the product and its quality. The angle of hue (h°) is measured in radian (0-360). If this factor (h°) reveals 90, 180 and 270, the colors signified are red, yellow and green respectively. The pure quantity in the least amount shows 0. When it rises, purity increases in such a way that more pure samples are expected to have livelier colors.

Sensory evaluation: For this purpose, preformed in two recurrences, 25 observers aging 25-35 (10 males, 15 females) were selected. The experiment was carried out in a cabinet lighting specified by D_{65} and under the observation condition 45/0 (angle of light 45, angle of observation 0). Any observer received a sample weighing 50_{gr}. This was packaging in a transparent disposable coded differently. The panel members were not allowed to smell or taste the samples and asked about the color of ketchup graded 1-5 i.e., they were asked if the color to what degree encouraged them in shopping. Ultimately the final result which is the average of two times experiments is eye catching.

Data analysis: Data collected from the aforementioned study samples were analyzed based on 0.05% coefficient of error by a software program called Minitab. At first such software program proved samples' normal conditions and then the significant difference among data was precisely studied via Non-parametric Kruskal-wallis test and p-value was determined.

RESULTS AND DISCUSSION

As shown in Table 3, color test result from 9 series ketchup samples with various formulations asserts while CMC is gradually being removed, yellow mustard increase. It also shows that adding mustard to ketchup formulation has resulted to changes in color specifications

Table 3: Effect of different concentration mustard on color properties

Mustard (%)	L*	a*	b*	ΔL^*	Δa^*	Δb^*	ΔE
0	31/239	18/113	12/391				
0.1	31/817	19/531	12/798	0/578	1/418	0/407	1/584
0.3	33/388	20/341	14/601	2/149	2/223	2/210	3/803
0.5	33/593	20/405	14/936	2/354	2/292	2/545	4/156
0.7	34/068	22/068	15/711	2/829	3/955	3/320	5/888
0.9	34/775	22/056	16/059	3/536	3/943	3/668	6/442
1.1	35/379	21/688	17/142	4/140	3/575	4/751	7/245
1.3	36/285	21/959	18/608	5/046	3/846	6/217	8/883
1.5	36/948	22/135	19/055	5/709	4/022	6/664	9/653

Table 4: Effect of different concentration mustard on c^* , h° , a/b and total ketchup color score

Mustard (%)	c^*	h°	a/b	Total ketchup color score
0	21.94	34.3781	1.46	9.318
0.1	23.34	33.2204	1.52	12.826
0.3	25.03	33.5461	1.44	13.004
0.5	25.27	36.199	1.36	13.22
0.7	27.08	35.4565	1.40	16.065
0.9	27.27	36.0505	1.37	15.762
1.1	27.63	38.3296	1.26	14.179
1.3	28.77	40.2773	1.18	13.532
1.5	27.92	43.8682	1.16	13.513

in final product. Added mustard to the formulation acclaims the increase in sample's lightness (L^*); Lightness values ranged from $L^* = 31/239$ (control) to 36/948 (1.5% mustard). Shade color of final product has a considerable increase in redness (a^*) from 18.113(control) to 22.135 (1.5% mustard) and yellowness (b^*) from 12.391 (control) to 19.055 (1.5% mustard). An insignificant increase of mustard to the formulation shows an increase in color distinction ($\Delta E_{a^*b^*}$) in comparison with non-mustard sample. The least difference belongs to the sample including 0.1% mustard. Mustard color is light yellow in itself, so the increase of concentration in the formulation brings about a considerable change in (b^*).

The study includes changes for the amount of (c^*), (h°) displayed in Table 4. Results show that through adding mustard amount of (c^*) increases; and (h°) turns into the orange hue. To study the color quality of product, different factors are used, among which the definite proportion redness over yellowness (a/b) is worth; and considering Eq. (5), it will be into reverse order with (h°). Of the usages of this quantity, indicating tomato paste quality is noticeable. If the above amount exceeds over 1.95, it can be claimed that the product is of good quality. As it has been reported in Table 4, it decreases while mustard is added which is not far beyond our expectation.

The USDA has declared a guideline to classify the ketchup products in which there is a factor called "Total ketchup color score" offering 17-20 scores qualitative. The score is the outcome of factors L^* , a^* , b^* calculated in the following formula: (USDA, 1992):

*TCS: Total Catchup Score
 $(TCS = -74,937 + 7,5172a - 0,1278a^2 - 0,8051b)$

Table 5: Effect of different concentration mustard on color (sensory evaluation)

Mustard (%)	Color score
0	3.25±2/82
0/3	3.65±0
0/5	3.25±2/82
1/1	3.25±2/82
1/5	3.25±2/82

Based on this formula, the TCCS of the ketchup sample studied is in Table 4. Therefore comparing USDA standard, color properties of the sample is far of suitability that sample without mustard showed lowest scoring (9.318). However it will be improved if mustard is added (from 12.826 to 16.065). Such formula asserts the most significant factor is product's tendency towards redness (a^*) which depends upon paste color in the ketchup formulation. As a result it can be said all factors raising the intensity of redness in tomato paste such as the appropriate tomato variety, tomato extraction process, blanching, temperature and time are to improve the TCCS. In this study adding mustard powder increases the redness of product and causes its TCCS reach international standards. Whether these changes seem suitable or which color sample has the best properties is just carried out through sensory evaluation. Table 5 shows no significance difference in data collected among samples.

Therefore mustard with concentration until 1.5% will not have any negative effect on final product color. What is more to say, observers even believe samples including higher mustard percentage look more clear and fresh and this matter which is proved by systematic analysis, the very increase of (C^*) amount.

CONCLUSION

In this study, Carboxy Methyl Cellulose (CMC) in tomato ketchup replaced by different concentrations of yellow mustard and its color properties were evaluated. The results of this study showed that adding yellow mustard to the ketchup formulations increased lightness (L^*) and redness (a^*) values. Samples prepared with 1.5% yellow mustard showed higher level of total ketchup color score as compare with samples contains Carboxy Methyl Cellulose. The result of this research revealed that by applying 1.5% yellow mustard as a natural thickener agent we successfully achieved a proper formulation for producing high quality tomato ketchup and health.

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