

## COLOR AND SENSORY CHARACTERISTICS OF BEEF PATTIES FORMULATED WITH TOMATO PASTE AND SUN-DRIED TOMATO POWDER

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### Background:

With current consumer interest in phytochemicals, manufacturers of traditional products have begun to examine ingredients that may serve to meet consumer desires as well as provide improvements in product quality. Tomatoes contain lycopene, a natural phytochemical with antioxidant activity (Nguyen and Schwartz, 1999). In the USA, tomatoes are readily associated with hamburgers or meat patties, and are generally provided in the form of fresh tomato slices. Additionally, consumers frequently apply tomato catsup to their patties as a food condiment. We explored tomato ingredients for incorporation into beef patty formulations and found tomato paste, a concentrate, and a new sun-dried tomato powder as potentially beneficial product additives. Formulations were tested to examine whether acceptable physical and sensory attributes could be provided with these products.

### Objectives:

The objective of this study was to determine the effects of tomato paste and sun-dried tomato powder on the color and sensory characteristics of beef patties.

### Methods:

Fresh ground beef (at approximately 20% fat) was initially mixed in a Hobart bowl mixer (Model A-200) for 2 min and divided into 5 treatments: control; 5 or 15% tomato paste (TPA); and 5 or 15% sun-dried tomato powder (TPO) (Valley Sun Tomato Products, Inc.). TPO was hydrated (hydration ratio 1:1) before formulation. Each patty treatment was mixed for 3 min, weighed into 100g portions, and formed into individual patties (9 cm dia). Smaller patties (7 cm dia) were made for visual color evaluation in the raw state. Individual patties were over-wrapped with PVC stretch film and held at  $4 \pm 1^\circ\text{C}$ .

Surface color of the raw patties was measured using a Minolta Chroma Meter CR-300. CIE L\* (lightness), + a\* (redness) and + b\* (yellowness) were obtained from 3 randomly chosen spots on the surface of each patty on the day of preparation. Redness index (a\*/b\*) was also calculated. The Chroma Meter was calibrated using the white calibration plate and Illuminant C was chosen as the source of illumination. For visual color evaluation of uncooked patties, 2 coded patties from each treatment (10 total) were randomly displayed on a white matte board under 786 lux of continuous lighting (cool white fluorescent) at  $4 \pm 1^\circ\text{C}$ . The day after patty preparation, a trained six member panel evaluated the uncooked patties for color characteristics as follows: surface color (1=fresh ground beef red, 2=orangish red, 3=orangish brown, 4=orangish yellowish brown), intensity of color (a=light, b=medium, c=dark), and color desirability (8 point scale: 8=extremely desirable, 1=extremely undesirable).

Sensory evaluation of cooked patties was conducted 2 days after initial preparation. Patties were cooked on a Calphalon rectangular griddle at  $177^\circ\text{C}$  until an internal temperature of  $68^\circ\text{C}$  was attained. Patties were then cut into 6 pieces and served simultaneously in random order in coded cups. The six trained panelists evaluated cooked patties for detectable surface color and interior color (1=very dark brown, 2= dark brown, 3= brown, 4=tan, 5=yellowish brown, 6=reddish brown, 7= orangish brown, 8= grayish brown), juiciness (8 point scale: 8= extremely juicy, 1=extremely dry), first detectable flavor (1=browned beef, 2= grilled ground beef, 3= fresh/clean, 4= acidic, 5=non-meat flavor, 6=greasy, 7=off, 8=other), second detectable flavor (same choices), flavor intensity (8 point scale: 8= extreme, 1=just recognizable), and flavor desirability (8 point scale: 8=extremely desirable, 1= extremely undesirable).

Data from three replications for all response variables were analyzed with general linear model procedure of SAS (1990). Separation of means was accomplished using the least significant difference test. Chi-square was used to analyze the responses of panelists evaluating the sensory attributes.

### Results and Discussion:

In the raw state, the control and 5% TPA and TPO-containing patties were generally lighter (CIE L\*) than patties containing 15% TPA and TPO (Table 1). Within TPA and TPO-containing patties, increasing the content from 5% to 15% decreased ( $P < 0.05$ ) surface lightness. Tomato paste (TPA) addition increased ( $P < 0.05$ ) surface redness (CIE a\*) of the patties whereas tomato powder (TPO) addition decreased ( $P < 0.05$ ) redness in comparison to the control patties. Both TPA and TPO sequentially increased ( $P < 0.05$ ) the yellowness of patties (compared to the control) with higher addition and the yellowness increase also affected the redness index (redness intensity) by significantly ( $P < 0.05$ ) decreasing it. Visual color scores (Table 1) for the raw patties followed a pattern similar to instrumental color measures. With the increasing concentration of tomato powder (TPO) and tomato paste (TPA), panelists noted increasing yellowness of the patties. For instance, the majority of the panelists evaluated patties with 5% TPO as "orangish brown" (% of total responses=50.0) and with 15% TPO as "orangish yellowish brown" (% of responses=83.3). Likewise, while 15% TPA-containing patties were evaluated as "orangish red" (% of responses=61.1), half of them scored patties with 5% TPA as "fresh ground beef red" and other half judged the color of the same patties "orangish red". All treatment groups had medium color intensity except patties with 15%TPO which were evaluated as having a "dark" color intensity. There was no difference ( $P > 0.05$ ) in color desirability scores among the control, 5% TPA, and 15% TPA-containing patties which ranged from moderately to very desirable. However, TPO addition imparted an undesirable color to the raw patties. Those with 5% TPO had a visual color score of 4.11 (slightly undesirable) and those with 15% TPO rated 2.61 (very undesirable). These visual differences in color attributes from the tomato ingredient additions may be a result of pH decreases (max.  $\Delta\text{pH} = -0.98$  from control) when added to the patties. The pH value is known to affect the color expressed by various tomato pigments.

Panelists evaluated color of the cooked patties (Table 2) and most frequently selected the detectable cooked surface color for the control and 5% TPA-containing patties as "brown" (% of responses for both=38.9) and for the 5%TPO-patties as "dark brown" (% of

responses=44.4). Those patties containing the 15% concentrations of TPA and TPO were evaluated as "orangish brown" (% of responses =55.6% and 77.8%, respectively). The majority of panelists evaluated cooked detectable interior color of the control and 5% TPA-containing patties as "reddish brown" (% of responses=72.2 for both) and patties of all of the other treatments as "orangish brown". For sensory taste characteristics, tomato paste (TPA) and powder (TPO) addition increased ( $P<0.05$ ) juiciness of the patties, with juiciness generally increasing with concentration increase from 5% to 15%. The first detectable flavor descriptor selected for the control and 5% TPA-containing patties was "grilled ground beef" (% of responses=83.3). While 38.9% of the panelists' responses for the 15% TPA-containing patties was "grilled ground beef", another 38.9% of the responses rated the first detectable flavor as "other", indicating it as "tomato" flavor. The most frequent first detectable flavor was evaluated as "other" for the 5% TPO (% of responses=38.9) and 15% TPO-patties (% of responses=66.7) and most panelists described it as "tomato" flavor. For flavor desirability, patties containing 5% TPA were found as desirable as the control. Flavor desirability scores for all patties, except those with 15% TPO, were in the range of 5.2 to 6.0 which equals slightly desirable to moderately desirable. The mean flavor desirability of the patties with 15% TPO was 3.7 which is slightly to moderately undesirable. Responses for a second detectable flavor were not required of panelists unless a second flavor was perceived. The most frequent descriptors for second detectable flavor were "browned beef" for the control (% of responses=50.0), "acidic" for 5% TPA (% of responses=45.5) and 15% TPA-patties (% of responses=35.7), "grilled ground beef" for patties containing 5% TPO (% of responses=45.5) and 15% TPO (% of responses=57.1). In all cases, the second detectable flavor intensities were "very slight" to "slight". Flavor desirability scores for the second detectable flavor were in the range of 4.7 to 5.5 which is slightly desirable to moderately desirable.

#### Conclusions:

On the basis of the results obtained for 80% ground beef patties, lower levels (5%) of TPO and TPA appeared to yield more acceptable color and sensory characteristics in the raw and cooked states as compared to higher levels (15%). Data suggest that TPA would be a more desirable ingredient than TPO for incorporation into ground beef patties, primarily due to color and flavor desirability.

#### Literature:

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**Table 1.** CIE lightness ( $L^*$ ), redness (+  $a^*$ ), yellowness (+ $b^*$ ) and redness index ( $a^* / b^*$ ) and visual raw color scores for beef patties formulated with tomato paste (TPA) and tomato powder (TPO)\*

Attributes	Control	5% TPA	15% TPA	5% TPO	15% TPO
Lightness ( $L^*$ )	52.52 <sup>c</sup>	51.39 <sup>c</sup>	48.70 <sup>b</sup>	50.45 <sup>bc</sup>	45.69 <sup>a</sup>
Redness ( $a^*$ )	18.80 <sup>a</sup>	21.77 <sup>d</sup>	23.06 <sup>d</sup>	16.67 <sup>b</sup>	13.07 <sup>a</sup>
Yellowness ( $b^*$ )	11.40 <sup>a</sup>	15.00 <sup>b</sup>	18.20 <sup>c</sup>	16.66 <sup>bc</sup>	20.08 <sup>d</sup>
Redness index ( $a^* / b^*$ )	1.65 <sup>c</sup>	1.46 <sup>d</sup>	1.27 <sup>c</sup>	1.00 <sup>b</sup>	0.65 <sup>a</sup>
Visual raw color (% of total responses)	Fresh ground beef red (100.0)	Fresh ground beef red & orangish red (50 - 50)	Orangish red (61.1)	Orangish brown (50.0)	Orangish yellowish brown (83.3)
Color intensity (% of total responses)	Medium (66.7)	Medium (55.6)	Medium (55.6)	Medium (72.2)	Dark (88.9)
Color desirability	6.78 <sup>c</sup>	6.83 <sup>c</sup>	6.55 <sup>c</sup>	4.11 <sup>b</sup>	2.61 <sup>a</sup>

\*Within a color attribute, means in the same row not having a common superscript letter are different ( $P<0.05$ ).

**Table 2.** The mean flavor desirability, flavor intensity, juiciness, and cooked surface and interior color scores for beef patties formulated with tomato paste (TPA) and tomato powder (TPO)\*

Attributes	Control	5% TPA	15% TPA	5% TPO	15% TPO
Surface color (% of total responses)	Brown (38.9)	Brown (38.9)	Orangish brown (55.6)	Orangish brown (44.4)	Orangish brown (77.8)
Interior color (% of total responses)	Reddish brown (72.2)	Reddish brown (72.2)	Orangish brown (77.8)	Orangish brown (38.9)	Orangish brown (100.0)
Flavor desirability	6.00 <sup>d</sup>	5.83 <sup>cd</sup>	5.28 <sup>bc</sup>	5.16 <sup>b</sup>	3.72 <sup>a</sup>
Flavor intensity	5.00 <sup>a</sup>	4.89 <sup>a</sup>	4.67 <sup>a</sup>	4.83 <sup>a</sup>	6.17 <sup>b</sup>
Juiciness	4.44 <sup>a</sup>	5.00 <sup>ab</sup>	5.83 <sup>c</sup>	5.44 <sup>bcd</sup>	5.88 <sup>d</sup>

\*Within an attribute, means in the same row not having a common superscript letter are different ( $P<0.05$ ).