# PORK PATTIES CONTAINING TOMATO POWDERS IMPROVED PHYSICO-CHEMICAL PROPERTIES AND ANTIOXIDANT ACTIVITY

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***Abstract*—This study was performed to evaluate antioxidant activity of oven-dried tomato powder as affected by water solubility, and physicochemical properties and antioxidant activity of pork patty containing tomato powders. Fresh tomatoes were homogenized and dried at 60℃ oven (TP). After diluted with water and stirred, then two different powders were collected by freeze-drying of water soluble solution (TWS) and residues from mixed solution of TP with water (TWI). TWI (water insoluble) showed higher activities for 1,1-diphenyl-2-picrylhdrazyl (DPPH) radical scavenging activity at 0.1% and iron chelating ability at 1% alone than other treatments. Pork patties containing 0.5% TWI had the highest redness and yellowness among other treatments ($p<0.05$). Thiobarbituric acid reactive substance (TBARS) of pork patties containing 0.5% all dried powders was lower than that of CTL1 ($p<0.05$) and not different from the reference (0.01% BHT)($p>0.05$). These results indicated that the lipid oxidation was suppressed with the addition of tomato powders in pork patties and thus, it could be used as a natural antioxidant in meat products for the partial replacement for synthetic antioxidant.**

***Index Terms*—antioxidant effect, pork patty, tomato powder, water solubility**

## I. INTRODUCTION

Lipid serve as a significant role in meat products as increase textural and functional properties such as cooking yield and water holding capacity (WHC) (Keeton, 1994; Pietrasik, 1999). However, lipid oxidation effects on a quality of meat and meat product such as flavor, color, texture and nutritional value (Eriksson, 1982). For these reasons, synthetic antioxidants such as butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and tert-butylhydroquinone (TBHQ) have been used in meat products for their ability to inhibit lipid oxidation. However, development of natural antioxidants is needed for substitute synthetic things due to these are harmful to human health (Branen, 1975).

Tomato is one of the widely cultivated and extensively consumed vegetable crops worldwide. Continuous consumption of tomato and tomato product can reduce risk of cancer and heart disease (Giovannucci, 1999). Especially, tomato containing lycopene, which is the major carotenoid compound giving the red color to the tomato. Lycopene is hydrophobic material that soluble in strong non-polar organic solvent such as chloroform and benzene (Shi, 2002), and has various anticancer effect (Clinton, 1998).

Many researches have been conducted to improve the functional and antioxidant properties of meat products using tomato (Candogan, 2002; Deda, Bloukas & Fista, 2007; Garcia, Calvo & Selgas, 2009; Kim et al., 2008; Osterlie & Lerfall, 2005). However, not many studies have performed to evaluate the quality of meat product using tomato powder as affected by water solubility. The aim of this study was to evaluate antioxidant activity of 60℃ oven-dried tomato powder, and its soluble and insoluble powder, and to evaluate antioxidant activity of three types of tomato powders in pork patty.

## II. MATERIALS AND METHODS

<u>Experiment I: Antioxidant activity of tomato powders as affected by water solubility</u>

### *A.* Preparation of tomato powders

Ripened fresh tomatoes were purchased from a local market. Prior to drying, fresh tomatoes were homogenized by mixer and then, dried at 60℃ oven (TP). After drying, they were extracted by stirring with water. After the aqueous solution was filtered with filter paper (Whatman No. 42), water soluble (TWS) and insoluble (TWI) tomato powders were obtained with freeze drying of the aqueous solution and residues, respectively.

### *B.* DPPH (1,1'-diphenyl-2-picrylhdrazyl)-radical scavenging activity

The radical scavenging activity of three types of tomato powders were measured based on their ability to scavenge DPPH-radicals, which were determined according to the method described by Huang, Tsai and Mau (2006).

*C*. Ferrous iron chelating ability

The ferrous ion chelating abilities of tomato powders were determined by measuring the inhibition of the formation of an $Fe^{2+}$-ferrozine complex using the method described by Le, Chiu and Ng (2007).

Experiment II: Physico-chemical properties and antioxidant activity of tomato powders as affected by water solubility in pork patty

*A*. Preparation of fresh pork patties

Fresh pork hams and back fats purchased from a wholesale meat market. The excess fat and connective tissue were removed, after which the pork hams and back fats were ground using a 0.32 cm plate and grinder (M-12s, Korea Fujee Plant, Busan, Korea). The ground hams and back fats were then homogenized with sodium chloride (NaCl) and tomato powder for 1 min using a meat mixer (EF20, Crypto Peerleso LTCL, UK).Then, the mixture was ground again using same grinder and plate, after which 80 g of the mixture were formed into one patty. The formed patties were then packaged using a polystyrene plate and stored at 4℃ until analyzed. The formulation of patties is listed in Table 1.

**Table 1. The formulation of pork patty with dried tomato powder at 60℃ dry oven**

| | CTL1 | CTL2 | TRT1 | TRT2 | TRT3 |
|---|---|---|---|---|---|
| Raw meat (%) | 78.5 | 78.5 | 78.5 | 78.5 | 78.5 |
| Fat (%) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Salt (%) | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| BHT (%) | | 0.01 | | | |
| Tomato powder (%) | | | 0.50 | | |
| Water soluble tomato powder (%) | | | | 0.50 | |
| Water insoluble tomato powder (%) | | | | | 0.50 |
| Total (%) | 100.00 | 100.01 | 100.50 | 100.50 | 100.50 |

*B*. pH and Hunter color measurement

The pH values were measured using a digital pH-meter (Mettler-Toledo, 340, Schwarzenbach, Switzerland). Briefly, a 10 g sample of pork patties was homogenized with 90 mL of dd-water using a food mixer, after which the pH values were measured five times and then expressed as average values.

The Hunter L (lightness), a (redness) and b (yellowness) values were measured five times on one patty using a Color Reader (CR-10, Minolta Corp., LTD, Japan), after which they were expressed as mean values. The colorimeter was calibrated against a white board (L = 91.7, a = 1.90, b = 1.20) prior to use.

*C*. Thiobarbituric acid reactive substances (TBARS)

TBARS values of pork patties were determined following the method described by Sinnhuber and Yu (1977).'

$$\text{TBARS value (mg malonaldehyde/kg)} = \text{optical density (O.D.)} \times 9.48 / \text{sample weight (g)}$$

*D*. Statistical analysis

The experiment was replicated at least twice, and the data were analyzed by two-way analysis of variance (ANOVA) using SPSS 17.0 for Windows. Significant differences among means were analyzed by Duncan's multiple range test ($p$<0.05).

## III. RESULTS AND DISCUSSION

### Experiment I: Antioxidant activity of tomato powders as affected by water solubility

DPPH radical scavenging activities of three types of tomato powder were increased with increasing concentration (Table 2, $p$<0.05). Especially, water insoluble powder, TWI showed significantly higher activity than other powders from 1.0% to higher concentrations ($p$<0.05). Basuny, Gaafar and Arafat (2009) reported an increase DPPH radical scavenging activity when more lycopene was added. Although we did not measure lycopene contents of three kinds of tomato powder, lycopene would be located in the insoluble portion, since it was hydrophobic material (Shi, 2002). Therefore, TWI, the water insoluble extract, showed higher activity at low concentration.

In case of iron chelating ability, their activities were increased with increasing concentration (Table 2, $p<0.05$), and more than 50% ion chelating activities were observed at 0.5% higher. Especially, TWI did not show the differences of ion chelating activities with EDTA ($p>0.05$) from 0.5%, and TP and TWS showed no differences with EDTA at 2.0%. Therefore, TWI showed more effective than TP and TWS in terms of ion chelating activity.

**Table 2. Antioxidant activities of tomato as affected by different water solubility**

| Parameters | Treatments[1)] | Concentration (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0.00 | 0.05 | 0.10 | 0.25 | 0.50 | 1.00 | 2.00 |
| DPPH radical scavenging activity | AA | $0.00^{b}$ | $92.9^{aY}$ | $93.5^{aX}$ | $93.5^{aW}$ | $92.5^{aY}$ | $93.3^{aX}$ | $93.5^{aX}$ |
| | TP | $0.00^{d}$ | $26.3^{cZ}$ | $30.6^{cZ}$ | $34.1^{cY}$ | $40.8^{cZ}$ | $60.9^{bY}$ | $81.8^{aY}$ |
| | TWS | $0.00^{e}$ | $21.1^{dZ}$ | $23.9^{cdZ}$ | $24.9^{cdZ}$ | $28.9^{cZ}$ | $36.2^{bZ}$ | $49.2^{aZ}$ |
| | TWI | $0.00^{e}$ | $24.2^{dZ}$ | $43.9^{cY}$ | $77.6^{bX}$ | $98.0^{aY}$ | $100^{aX}$ | $97.7^{aX}$ |
| Iron chelating activity | EDTA | $0.00^{b}$ | $99.4^{aY}$ | $99.4^{aY}$ | $99.5^{aY}$ | $99.3^{aY}$ | $99.3^{aX}$ | $99.5^{a}$ |
| | TP | $0.00^{c}$ | $34.4^{bZ}$ | $33.3^{bZ}$ | $45.1^{bZ}$ | $58.0^{abZ}$ | $76.8^{aZ}$ | $79.7^{a}$ |
| | TWS | $0.00^{e}$ | $29.6^{dZ}$ | $34.6^{cdZ}$ | $46.5^{cZ}$ | $62.5^{bZ}$ | $79.4^{aYZ}$ | $90.8^{a}$ |
| | TWI | $0.00^{d}$ | $37.9^{cZ}$ | $29.8^{cZ}$ | $47.1^{cZ}$ | $82.1^{bYZ}$ | $92.7^{abXY}$ | $99.5^{a}$ |

[a-e]Means with different superscripts in the same row are different ($p<0.05$).
[W-Z]Means with different superscripts in the same row are different ($p<0.05$).
[1)]Treatments: AA= L-ascorbic acid; TP= Dried tomato powder at 60℃ oven; TWS= Water soluble extracts from dried tomato powder at 60℃ oven; TWI= Water insoluble extracts from dried tomato powder at 60℃ oven; EDTA= Ethylendiaminetetraacetic acid.

**Experiment II: Physico-chemical properties and antioxidant activity of tomato powders as affected by water solubility in pork patty**

Since there is no interaction between treatments and storage time in pH and color, data were pooled (Table 3). pH was increased with increasing storage time ($p<0.05$) and no differences in pH were observed among treatments ($p>0.05$). Redness was reduced with increasing storage time ($p<0.05$). Among the controls and treatments, patties with water insoluble powder (TRT3) showed the highest a and b values (redness) and those with BHT 0.01% (CTL2) showed the highest a values than CTL1 ($p<0.05$). These results suggested that TRT3 maintained colorant safely until end of storage (Osterlie and Lerfall, 2005).

**Table 3. The result of product properties in pork patty with various tomato powder**

| | Parameters[1)] | | | | |
|---|---|---|---|---|---|
| | pH | Hunter L | Hunter a | Hunter b | TBARS |
| Treatments[2)] | | | | | |
| CTL1 | 5.65 | 58.1 | $8.81^{c}$ | $7.11^{d}$ | $1.33^{a}$ |
| CTL2 | 5.61 | 58.4 | $9.58^{ab}$ | $7.41^{cd}$ | $0.76^{b}$ |
| TRT1 | 5.56 | 57.6 | $9.38^{bc}$ | $8.36^{b}$ | $0.61^{b}$ |
| TRT2 | 5.53 | 57.8 | $9.09^{bc}$ | $7.87^{bc}$ | $0.82^{b}$ |
| TRT3 | 5.63 | 57.2 | $10.2^{a}$ | $9.04^{a}$ | $0.68^{b}$ |
| Days | | | | | |
| 0 | $5.37^{d}$ | $57.4^{ab}$ | $14.0^{a}$ | $8.81^{a}$ | $0.16^{d}$ |
| 3 | $5.41^{cd}$ | $56.7^{b}$ | $10.8^{b}$ | $7.24^{d}$ | $0.59^{c}$ |
| 7 | $5.47^{c}$ | $58.3^{a}$ | $8.02^{c}$ | $7.56^{cd}$ | $0.91^{b}$ |
| 10 | $5.65^{b}$ | $58.5^{a}$ | $7.24^{d}$ | $7.72^{bc}$ | $0.99^{b}$ |
| 14 | $6.08^{a}$ | $58.3^{a}$ | $7.02^{d}$ | $8.27^{ab}$ | $1.55^{a}$ |

[a-d]Means with same letter into same column are not different ($p>0.05$).
[1)]Parameters: Hunter L= Lightness; Hunter a= Redness; Hunter b= Yellowness; TBARS= Thiobarbituric acid reactive substance.
[2)]Treatments: CTL1= Control patty; CTL2= Reference patty with BHT 0.01%; TRT1= Treatment patty with tomato powder dried at 60℃ oven; TRT2= Treatment patty with water soluble tomato powder dried at 60℃ oven; TRT3= Treatment patty with water insoluble tomato powder dried at 60℃ oven.
NS = not significant; * indicates $p<0.05$; ** indicates $p<0.001$.

TBARS was conducted to determine the lipid oxidation (Table 3). TBARS value of patty with all tomato powders (TRT 1, 2 and 3) was lower than control patty ($p<0.05$) and similar to those of patty added BHT 0.01% (CTL 2)($p>0.05$). Therefore, the addition of tomato powder into pork patties might be suppressed lipid oxidation. Candogan (2002) studied product quality of beef patty with tomato paste and found that patties treated with tomato paste showed lower TBA values than controls ($p<0.05$) during 9 days of refrigerated storage.

## IV. CONCLUSIONS

Water insoluble tomato powder showed more effective DPPH-radical scavenging activity and iron chelating ability than others in model study. Pork patties with 0.5% water insoluble powder (T3) showed higher redness and yellowness ($p<0.05$), and patties with three types of tomato powders showed lower TBARS value than controls ($p<0.05$). Since various types of tomato powders effectively suppressed lipid oxidation of pork patties, they could be used as a natural antioxidant for the substitution of synthetic antioxidant.

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