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Novel high antioxidant functional ketchup produced from tomatoes and golden berry mixture

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Abstract

The antioxidants role in human nutrition has gained an increased attention, especially due to their associated health effects. Tomatoes have rich sources of key antioxidant components. Golden berry is comparatively tomato-like in flavor and appearance as well as richer taste with significant health benefits because of its high antioxidants, vitamins, and minerals. In this study, the impact of substituting tomato juice with different levels (25, 50, 75, and 100 %) of golden berry juice on the bioactive compounds and quality criteria of formulated Ketchup were evaluated. The fresh golden berry juice had recorded a total soluble solid three times more than tomato juice. Golden berry juice also showed higher titertable acidity (1.94%) with a pH of 3.28 compared to 0.51% acidity and pH 4.2 for tomato juice. Meanwhile, Tomato juice had lower contents of protein, fat, total carbohydrates, fiber and ash. Golden berry juice contained a high amount of phenolic and flavonoid compound as well as ascorbic acid and consequently total antioxidant activity. Generally, ketchup formulated from 100% golden berry had a high fat, carbohydrate, fiber and ash with a low protein contents. While, no differences in pH value and acidity content of 100% golden berry ketchup formula compared to 100% tomato formula. Increasing the substitution levels of tomato juice with golden berry juice improved significantly ($P \leq 0.05$) the total phenolic, flavonoids, ascorbic acid and consequently the antioxidant activities of the formulated ketchup. The trained panelists accept the substitution levels of golden berry up to 75%.

Key words: Ketchup, golden berry, bioactive compounds, phenolic, flavonoid, ascorbic acid**.**

Introduction

Tomatoes, *Lycopersicon esculentum mill*, constitute an important agricultural crop and an integral part of the human diet all over the world. In spite of the fact that, the tomato is usually consumed fresh, over 80% of the tomato consumption comes from processed products **(Rao *et al*., 1998 and Thakur *et al*., 1996)**. Tomato ketchup is a clean product, which made from properly prepared strained tomato with spices, salt, sugar, and vinegar with or without starch, onion, and garlic and contains not less than 12% tomato solids. Ketchup is the most important product of tomato and is consumed extensively **(Gupta, 1998)**. Commercial ketchup have an extremely variable composition; based on the quantity, number and amount of spices are other flavoring agent used **(Rao, 1987)**. Many newly developed tomato products with or without other vegetable juices are now appearing in the market, among these new products are still not enough the requirements of the consumer. (**Porretta and Birzi, 1995)**.

Golden berry (*Physalis peruviana* L.) is a solanaceous plant native totropical in South America **(Gutierrez *et al*., 2008; Hareedy, 2000** and **Trinchero*et al*., 1999).** It has grown in Egypt, India, South Africa, Australia, New Zealand and Great Britain **(Mc Cain, 1993; Ramadan and Mörsel, 2003; Rehm and Espig, 1991)**. Golden berry has significant health benefits because of its high antioxidants, vitamins, minerals and fiber **(Zhao, 2007)**. Also, it a very interesting material for the processing of some foods as sauces and relishes in place of tomato in North America **(Su *et al*., 2002)** as well as different new functional foods and drinks **(Ramadan, 2011)**. This fruit represent an important and significant source of bioactive compounds such as ascorbic acid, vitamin B complexes, vitamin A, minerals, carotenoids and tocopherols **(Bravo and Osorio 2016)**. These bioactive compounds provide health benefits, because they are anti-inflammatory, hepatoprotective, antioxidant, anti-diabetic, anticarcinogenic and prevention of cardiovascular diseases (CVD) and coronary heart disease **(Ramadan 2011; Ramadan, 2013** and **Zapata *et al*., 2016)**. On the other side, it is a promising plant for the development of a phytomedicine against many diseases. Although golden berries are generally commercialized as fresh products, the fruits are also used in sauces, syrups, and marmalades or dehydrated (similarly to grape raisins) for use in bakeries cocktails, snacks, and cereal breakfast. In general, it can be used for the food and industrial application **(Puente *et al*., 2011).** Where, there are no enough products to meet the consumer requirements as functional ketchup. Therefore, present work was devoted to develop a novel acceptable high antioxidant ketchup product formulated by mixing different levels of tomato juice and golden berry.

Materials and Methods:

Materials

Cape golden berry fruit (*Physalis peruviana* L.) and tomato fruits (*Lycopersicon esculentum mill*) were purchased from Experimental Farm Abu-El Matamir Al-Buhayrah, Egypt during winter seasons 2016/2017. Intact golden berry fruits were carefully selected according to the degree of ripeness measured by fruit color (brilliant orange).

Chemicals and Reagents:

Oxalic acids, sodium hydroxide, hydrochloric acid, tannic and citric acid were purchased from El-Nasr Pharmaceutical Chemicals, Cairo, Egypt. Anhydrous glucose, Folin-Ciocalteu, was purchased from Sigma Chemical Co., St. Louis, MI Dichloromethane, sodium sulphate anhydrous, starch, gallic acid, 1,1-diphenyl-2-picrylhydrazyl (DPPH), reagent, nalkanes and methanol, were purchased from Aldrich and sigma company, Germany.

Methods

Technological methods:

Ketchup processing

Fresh tomato and golden berry fruits were separately washed, crushed, scalded at 90˚c for 5 min, and juice was obtain in the usual way after sieving and then filled in bottle then cooled. The obtained tomato and golden berry juices were transferred to an open kettle which was heated until the concentration reached to 22 brix, then the concentrated golden berry was added to the concentrated tomato by 25, 50, 75% (with keeping to original samples 100 % tomato and 100% golden berry) then the spices (sodium chloride, sugar, onion and garlic powder), mixed for 5 minutes then the vinegar was added heated on a low flame with constant stirring until the final Total solids substances (TSS) was reached (approximately 32 brix). While still hot, ketchup samples were poured into glass jars, sealed with rubber seal screw caps, and then stored at ambient temperature (20-22˚C) for 24 h before the analyses **(kamil *et al*., 2011)** and **Apaiah** and **Barringer, 2007** with some modification**)**.

2.2.2. Chemical methods

2.2.2.1. Proximate composition

Moisture, ash, nitrogen content, fat (ether extract) and crude fiber were determined according to the method described in **AOAC, (2005)**. Total carbohydrate was determined by method of **Dubois *et al*., (1956)**. Ascorbic acid was extracted in 2% oxalic acid and determined using 2, 6 dichlorophenolindo phenol according to **Anonymous, (1966)**.

Physico chemical analysis

The pH was measured with a jenway PH meter. Titratable acidity was determined by titration with 0.1 N NaOH solution using phenolphthalein as the indicator according to **(AOAC, 2005)**. Total solid was calculated by subtracting the moisture content from 100. Total soluble solid was determined using Abbe refractometer (Carl zeiss GENA, GDR).

Total phenolic content (TPC)

The total polyphenols content of the formulated ketchup 5 formulas, (100% tomatos), (75% tomatoes +25% golden berry), (50% tomatos +50% golden berry), (25%tomatos +75%golden berry) and (100% golden berry) as well as tomato and golden berry pulps was determined colorimetric ally at 725 nm using the Folin-Ciocalteau reagent according to the modified method described by (**Taga *et al*., 1984)**. Tannic acid served as a standard for preparing the calibration curve, and ranged from 2.5 to 20 µg/25 µl of assay solution.

Radical scavenging activity (DPPH)

The radical scavenging activity of the formulated ketchup (5 formulas) as well as tomato and golden berry pulps were tested as bleaching of the stable DPPH radicals according the procedure described by (**Brand-Williams and Cuvelier, 1995)**. The radical scavenging activities of the tested samples, expressed as percentage inhibition of DPPH, were calculated according to the following formula: % Inhibition = $100 \times (A - A_0) / A$

Whereas A is the absorbance at 515 nm of the control sample at zero time (min) and A_0 is the final absorbance of the test sample.

Determination of total flavonoid content

The total flavonoid content was determined according to **Zilic *et al*., 2012** using aluminum chloride ($AlCl_3$) colorimetric assay. The total flavonoid content was determined by means of a calibration curve prepared with catechin, and expressed as milligrams of catechin equivalent (mg CE) per g of sample. Additional dilution was done if the absorbance value measured was over the linear range of the standard curve.

Microbiological analysis

Samples preparation

Twenty-five g of each sample was mixed and homogenized in sterile mixer, and diluted with buffered peptone water to make the sufficient dilutions for the microbiological analysis. Ten-folds dilutions of homogenates or liquid samples were prepared and inoculated into plates of selective media.

Yeasts and moulds count

Enumeration of yeasts and moulds were carried out using the potato dextrose agar medium. Plates were incubated at 22-25º C for 3-5 days, colonies of yeasts and moulds were counted and calculated per gm or ml of sample **(FDA, 2002)**.

Detection and enumeration of coliform

Coliform group was determined using solid medium method onto plates of violet red bile agar medium, plates were incubated for 24 hrs at 35 ºc. Coliform group to be counted will produce purple colonies surrounded by purple halos **(FDA, 2002)**.

Detection and enumeration of *Salmonella typhimurium*

Aseptically (25 g) of each sample was mixed with 225 ml of sterile buffer peptone water and incubated at 35 ºC for 24 hrs. One to ten ml mixture was transferred to selenite cystein broth and incubated at 35 ºC for 72 hrs. Plates of *Salmonella and Shigella* ager were streaked and incubated at 35 ºC for 24 hrs. Growth of

Salmonella typhimurium is appears as colourless colonies with black centers **(FDA, 2002).**

Color attributes

Ketchup samples were measured for color using a Minolta Colorimeter CR- 300 (Konica Minolta Business Technologies, Inc., Langenhagen Hannover, GERMANY) as CIE L*, a*, b* values. The color parameters were defined as L*, a*, b* system (psychometric light L*, psychometric tone a* and Chroma b*).In this coordinate system L* value is a measure of lightness ranging from black to white, a* value ranges from – (greenness) to + (redness) and b* ranges from – (blueness) to + (yellowness). Total color change (ΔE) was calculated according to the following formula (**Barreiro *et al*., 1997; Rajchl *et al*.,2010**)

$$\Delta E = \sqrt{(L - Lc)^2 + (a - ac)^2 + (b - bc)^2}$$

Sensory evaluation of ketchup:

Sensory evaluation was conducted on ketchup sample after one-day storage at room temperature (**Piggott, 1984)**. Sensory characteristics (appearance, color, texture, taste, flavor and overall acceptability) were evaluated by fifteen trained panelists, who were stuff members of food technology institute. Panelists were selected based on their interest and availability. Three training sessions (1hr each) were conducted prior to evaluation in which the panelists were trained to be familiar with attributes and scaling procedures of ketchup samples. Sensory attributes were evaluated using a nine point hedonic scales with 1 = the lowest or extremely dislike and nine= the highest or extremely like. All ketchup samples were randomly coded and presented to the panelists on white plates at room temperature. Lighting of the sensory evaluation lab was the same throughout the analysis.

Statistical analysis

The data analysis of this experiment was carried out by using the Statistical Analysis System **(SAS, 2004)**. Measured data were analyses by **ANOVA**. Least Significance Difference test was used to determine differences between means. Significance was assumed at ($P \leq 0.05$).

Results and Discussion:

Physico-chemical and chemical characteristics of fresh tomatos and golden berry juice:-

Data of physico-chemical and chemical characteristic fresh tomatos and golden berry Juice were showed in table (1). The solids contents represent the main factor for ketchup production it is well known that the higher the total solids the higher the ketchup yields. The fresh golden berry juice had a total soluble solid three times more than tomato juice. Golden berry juice also showed higher titertable acidity (1.94%) with a pH of 3.28 compared to 0.51% acidity and pH 4.2 for tomato juice. Tomato juice had lower contents of protein (0,83%), fate (0.21%), total carbohydrate (5.8 %), fiber (1.81%) and ash (0.61%) compared with 1.19%, 0.78%, 9.17%, 4.56% and 1.85% for golden berry juice , respectively. These data are found to be in the same range of that previously reported by **Ramadan *et al.* (2013); Sanchez-Moreno *et al.* (2016) and El-Beltagy *et al.* (2013)** for golden berry juice and close to that published by **Prakash *et al.* (2016)** for tomatoes juice.

Table (1). Chemical and physic-chemical characteristics of fresh tomato and golden berry juice.

Constituents	Tomato juice	Golden berry juice
Moisture (%)	90.74±3.1	82.45±2.7
Protein(%)	0.83±0.31	1.19±0.09
Fat (%)	0.21±0.05	0.78±0.05
Total carbohydrates (%)	5.8±1.95	9.17±1.41
Fiber (%)	1.81±0.22	4.56±0.53
Ash (%)	0.61±0.17	1.85±0.11
PH	4.2±0.32	3.28±0.12
Titratable acidity(%)	0.51±0.10	1.94±0.15
Total soluble solids(%)	4.6±1.11	13.13±0.09

Bioactive compounds and antioxidant activity of tomato and golden berry juice

Phenolic compounds tend to accumulate in the plant tissues because of their potential protection role against ultraviolet radiations, to act as attractants in fruit dispersal, and as defense chemicals against pathogens and predators **(Strack, 1997)**. In this study, golden berry juice contained a significantly ($P\leq 0.05$) high amount of phenolic and flavonoid compound as well as ascorbic acid and consequently total antioxidant activity **(Table 2)**. It contained a considerable (P≤ 0.05) amount of polyphenols (16.72 mg/100 g) as tannic acid compared with that detected in tomato juice (9.51 mg/100 g). A considerable amount of phenolic compounds were detected in Cape golden berry, wherein the total phenols content was 6.30 mg/100 g juice as caffeic acid equivalents (CAE) **(Ramadan and Mörsel, 2007)**. Meanwhile, the golden berry contained a high (P≤ 0.05) amount of flavonoids (4.81 mg/100 gm as catechin equivaleuil, CE) compared to 3.54 for tomato juice. Also, golden berry had a twice amount of ascorbic acid compared with tomato juice. The antioxidant activity of cape golden berry juice was assessed by means of a 1,1-diphenyl-2-picrylhydrazyl (DPPH) test. Fresh golden berry juice produces a 45.36% decrease vs. the absorbance of DPPH radicals' control solution compared with 29.74% decrease for tomato juice. Phenolic compounds are the main responsible agent for the antioxidant activity of juices and wines, whereas, ascorbic acid had a minor role in the antioxidant efficiency of juices **(Meyer, *et al*., 1995; Rapisarda *et al*., 1999). In similar study, Miller and Rice- Evans 1997** underlined the significant contributory role of phenols to the antioxidant activity of orange juice, even if vitamin C was the most abundant antioxidant. The presence of a good amount of phenolic compounds in Cape gooseberry fruits, might contribute to the high level of its antioxidant capacity.

Table (2). Flavonoid, phenolic, ascorbic and antioxidant activity of tomato and golden berry juice

Constituents	Tomato juice	Golden berry juice	LSD
Total polyphenol (mgTAE/100gm)	9.51^{b}±1.71	16.72^{a}±2.15	1.32
Total flavonoid (mg CE /100gm)	3.54^{b}±0.93	4.81^{a}±0.90	0.95
Ascorbic acid (mg/100gm)	24.32^{b}±3.71	51.30^{a}±4.22	1.62
Antioxidant activity (%)	29.74^{b}±2.15	45.36^{a}±1.98	1.88

Means with the different letters in the same row are significantly different at P ≤ 0.05

Physicochemical and chemical characteristics of ketchup formulated with a mixture of tomato and golden berry juices.

The chemical constituents of the ketchup formulated by substituting tomato juice with different levels of golden berry juice are given in **Table (3)**. Generally, no significant differences were detected in total solid of all blends (ranged from 32.25 to 30.86%) which revealed a moisture contents between 67.75 and 67.14%. The ketchup formulated with 100% tomatos had significantly ($p \leq 0.05$) high protein content (4.98%) compared to that formulated with 100% golden berries (3.10), while no significant differences were detected in the other blends. Meanwhile, the fat content had an opposite trend. No significant differences were detected in ketchup formulated with100% tomato and golden berry juice substitution levels up to 75%. Titritable acidity and pH did not change ($P \leq 0.05$) with increasing the golden berry substitution levels. The physicochemical constituents of golden berry and tomato were found to be in the range of the earlier reports published by **Prakash *et al*. (2016)** and **El-Beltagy *et al*. (2013)** for golden berry and tomato, respectively.

Table (3). Effect of substituting tomato juice by deferent levels of golden berry juice on chemical constituents of ketchup.

Constituents	Control	golden berry substitution levels				L.S.D
		25%	50%	75%	100%	
Moisture	$67.75^{a}\pm2.18$	$67.60^{a}\pm3.35$	$67.14^{a}\pm4.41$	$67.33^{a}\pm3.73$	$67.23^{a}\pm4.32$	0.63
Protein	$4.98^{a}\pm0.13$	$4.55^{ab}\pm0.26$	$4.05^{b}\pm0.31$	$3.41^{bc}\pm0.22$	$3.10^{c}\pm0.28$	0.73
Fat	$1.21^{b}\pm0.39$	$1.28^{ab}\pm0.22$	$1.53^{ab}\pm0.01$	$1.65^{ab}\pm0.12$	$1.70^{a}\pm0.05$	0.45
Total carbohydrates	$15.31^{b}\pm1.54$	$15.40^{ab}\pm1.43$	$15.71^{ab}\pm1.68$	$16.02^{ab}\pm2.15$	$16.10^{a}\pm2.53$	0.72
Fiber	$7.20^{b}\pm1.11$	$7.29^{b}\pm0.63$	$7.47^{ab}\pm0.81$	$7.43^{ab}\pm0.67$	$7.60^{a}\pm1.01$	0.45
Ash	$3.55^{c}\pm0.56$	$3.88^{b}\pm0.49$	$4.10^{ab}\pm0.33$	$4.16^{a}\pm0.43$	$4.27^{a}\pm0.18$	0.31
PH	$3.41^{a}\pm0.18$	$3.44^{a}\pm0.12$	$3.32^{a}\pm0.25$	$3.30^{a}\pm0.15$	$3.20^{a}\pm0.35$	0.25
Total solids	$32.25^{a}\pm2.67$	$32.40^{a}1.23$	$32.86^{a}\pm3.13$	$32.67^{a}\pm2.57$	$32.77^{a}\pm3.44$	0.62
Treatable acidity	$1.81^{a}\pm0.27$	$1.71^{a}0.13$	$1.70^{a}\pm0.11$	$1.71^{a}\pm0.18$	$1.9^{a}\pm0.24$	0.22

Means with the different letters in the same row are significantly different at $P \leq 0.05$

Bioactive compounds and antioxidant activity of ketchup

Generally, substitution of tomato juice with different levels of golden berry juice improved the contents of bioactive compounds and antioxidant activity. **(Table 4)** The ketchup formulated with 100% golden berry had the highest (p≤0.05) amounts of total phenolic (33.78 mg Tannic/100gm), total flavonoids (9.87 mg Catechin/100 gm), ascorbic acid (95.31 mg/100gm) and antioxidant activity (64.03%) compared to the other blends .On the other side, the ketchup formulated with 100% tomato had the lowest (p≤0.05) total phenolic (28.51mg Tannic/100gm), ascorbic acids (81.32 mg/100gm) and antioxidant activity (35.18 %). The breakdown of phenolics during thermal processing might have led to such reduction **(Prakash *et al*.,2016).** In similar study **Gahler *et al.* (2003)** reported that the preparation of tomato sauce and tomato soup did not affect the contents of Vitamin C, when the results were calculated based on the fresh matter but showed a decrease when calculated based on dry matter. In another study by **Abushita *et al*. (2000)**, about 50 % of the vitamin C seemed to be lost during thermal processing of tomatoes. Loss of ascorbic acid occurs primarily via chemical degradation that involves oxidation of ascorbic acid to dehydroascorbic acid, followed by further polymerization to form other nutritionally inactive products. This reduction of ascorbic acid in the ketchup as compared to the fresh pulp could be due to thermal processing which is known to speed up the oxidation process of ascorbic acid **(Dewanto *et al*., 2002 and Prakash *et al*., 2016).** Further move **Parakash *et al*., (2016)** stated that processing of tomatoes into ketchup retained 18-29% of ascorbic acid, 11-70% phenolic conten and 24-42 flavonoid contens.

Table (4): Bioactive compounds and antioxidant activity of ketchup formulated with a mixture of tomato and golden berry juice.

Compounds	Control	golden berry substitution levels				L.S.D
		25%	50%	75%	100%	
Total polyphenol (mg TAE / 100 gm.)	28.51^{d}±2.18	30.14^{c}±2.57	30.95^{c}±3.11	32.47^{b}±2.95	33.78^{a}±1.81	0.82
Total flavonoids (mg CE / 100 gm.)	8.10^{c}±0.63	8.16^{c}±1.01	8.55^{c}±0.77	9.14^{b}±0.46	9.87^{a}±0.84	0.63
Ascorbic acid (mg/100gm)	81.32^{e}±5.17	84.25^{d}±3.28	87.38^{c}±4.68	91.11^{b}±5.15	95.31^{a}±6.33	1.25
Antioxidant activity (%)	35.18^{e}±2.85	46.78^{d}±2.37	54. 10^{c}±4.41	59.43^{b}±4.33	64.03^{a}±3.97	1.78

Means with the different letters in the same row are significantly different at P ≤ 0.05

Sensory attributes of ketchup

From the consumer’s viewpoint the main guide of the food quality is the organoleptic attributes'. Therefore, sensory evaluation was conducted to determine the highest acceptable ketchup formulations. Color and flavor is the first thing that attracts us and then the other factors comes **(Janette *et al*., 2008)**. The perceived color of the ketchup formulated with 25% substitution level was significantly higher ($P \leq 0.05$) than that recorded for control (100% tomato), meanwhile no significant ($P \leq 0.05$) differences were observed among the other recipes **(Table 5)**. The texture of the sample formulated with 100% golden berry was the lowest compared to the other recipes. No significant ($P \leq 0.05$) differences were noticed among all recipes in taste and appearance. Also, no significant differences were observed among all recipes (up to 75% substitution level) in flavor and over all acceptability. Since one of the main aims of this study is to compare the sensory properties of the ketchup formulated with 100% tomato juice with that formulated with different substitution levels of golden berry, the obtained results encourage applying the new recipes in industrial scale. The panelists accepted the substitution level of golden berry up to 75% consequently we expect a good marketability of the ketchup formulated with tomato substituting with different levels of golden berry (up to 75%) the extent to which the golden berry ketchup is perceived to be marketed. On the other side, Consumers have different tastes, behavior and perspective in buying food products. One of the factors that will attract customers to buy food products its nutrition content which might be the main reason for accepting the ketchup formulating with 100% golden berry for its high nutritional aspects. Our results are in the same trend of that reported by **Mahmood, *et al*, (2017)** who stated that the ketchup prepared by mixing 50% tomato pulp and 50% bottle ground pulp had the best organoleptic properties. It also, too close to that reported by **Parakash *et al.* (2016)** who stated that the ketchup formulated by 75% acerola and 25% tomatoes showed the best overall quality.

Table (5): Effect of substitution of tomato juice by deferent levels of golden berry juice on sensory characteristics of ketchup.

Blinds	Color (10)	Texture (10)	Taste (10)	Flavor (10)	Appearance (10)	Over all acceptability
Control	7.13[b]±0.53	7.25[ab]±0.41	7.16[a]±0.70	7.41[a]±0.39	7.43[a]±0.72	7.38[a]±0.63
25%	8.19[a]±0.66	7.58[a]±0.63	7.06[a]±0.52	7.58[a]±0.44	7.90[a]±0.59	7.91[ab]±0.29
50%	7.75[ab]±0.71	7.16[ab]±0.68	7.03 [a]±0.75	7.30[a]±0.63	7.38[a]±0.45	8.19[a]±0.56
75%	7.91[ab]±0.49	7.66[b]±0.57	7.00[a]±0.16	7.83[a]±0.32	7.68[a]±0.33	7.75[ab]±0.65
100%	7.38[ab]±0.55	6.83[c]±0.38	6.18[ab]±0.48	6.83[b]±0.68	7.98[a]±0.25	7.13[b]0.47
L.S.D.5%	0.86	0.80	0.92	0.80	0.78	0.86

Means with the different letters in the same row are significantly different at $P \leq 0.05$

Color attributes

Different color parameters L*, a* and b* were measured in all different ketchup recipes to determine whether the substitution of tomato with different levels of golden berry could significantly improve the quality of color **(Table 6)**. Generally, increasing the substitution level the decreasing the product lightness. The sample redness decreased by increasing the substitution levels up to 50%, the highest degradation of red color was recorded in ketchup formulated with 100% golden berry with a* value 10.24 compared to 17.86 for that formulated with 100 tomato. Such decrease of the product rediness might be attributed to the decreasing in the anthocyanin amount via the degradation of anthocyanin pigment during the processing. The high loss of anthocyanin might be due to it's high sensitivity to many factors such light, pH and temperature **(Falcao *et al.* 2009).** Also, 32% decreases of lycopene via oxidation and isomerization due to the heat exposure **(Srivastava and Srivastava, 2015).** Generally, increasing the substitution level (up to 75%) increased ($P \leq 0.05$) the yellowness of the product. Furthermore, the ketchup formulated with 75% substitution level had the highest ($P \leq 0.05$) b* value (32.61) which revealed that the highest yellow color.

Table (6): Effect of substitution tomato juice by deferent levels of golden berry juice on color parameter of ketchup.

Blinds	L*	a*	b*	ΔE
Control	49.35[e]±3.54	17.86[a]±1.11	16.58[e]±1.36	0
25%	50.48[d]±2.21	17.14[a]±0.93	21. 90 [d]±1.19	5.48
50%	51.08[c]±5.11	15.64[b]±1.08	28. 21[b]±2.27	11.96
75%	53.69[b]4.56	14.00[c]±1.23	32.61[a]±2.65	17.05
100%	55.85[a]±4.72	10.24[d]±0.95	26.64[c]±2.15	14.20
LSD	0.52	0.73	0.67	1.8

Means with the different letters in the same row are significantly different at P ≤ 0.05

Microbiological examination.

Such as shown in **(table 7)** all samples were free of *salmonella* spp., coliform bacterial count through storage time that reported by Egyptian standard **(ES: 132-3, 2005)**. The mold and yeast count not detected up to the six month of storage in ketchup formulated with any percent of golden berry. Meanwhile, the ketchup formulated with 100% tomatoes showed a 15 and 100 cfu after storage for 4 and 6 month respectively.. This might be due to the ripe golden berry contain benzoic acid, flavonoid, and anthocyanin, all of which can have antibacterial action **(Ördögh *et al.*, 2010 and Wang *et al*., 2012; Göztok and Zengin, 2013)** Which demonstrated an antibacterial activity against both Gram-positive and Gram-negative bacteria **(Puupponen-PimiŠ *et al*., 2001; Ryan *et al*., 2001; Cavanagh *et al*., 2003; Lee *et al*., 2003 and Bernal *et al*., 2015)**.

Table (7): Effect of substituting tomato juice by deferent levels of golden berry juice on microbiological aspects of ketchup

Blinds	Storage time (months)			
	Zero	**2**	**4**	**6**
Control	ND	ND	15	100
25%	ND	ND	ND	ND
50%	ND	ND	ND	ND
75%	ND	ND	ND	ND
100%	ND	ND	ND	ND

ND: not detected

Conclusion

Consumers have different tastes, behavior and perspective in buying food products. One of the key factors that will attract customers to buy food products is its nutritional content. This study suggests potent ketchup formulas which contain a mixture of tomato and golden berry juice with enhanced bioactive compounds which might be one of the main reasons for accepting the new ketchup formulas because of the potentially protective properties of such high antioxidant products which recently have great interest and the consumer has already become aware of their potential importance. Data of the present study strongly revealed that substitution tomato juice with 75% of golden berry juice could resulted in potent acceptable ketchup with good quality attributes.

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انتاج كاتشب وظيفي مبتكر غني بمضادات الاكسدة من مخلوط الطماطم والحرنكش

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ازداد الاهتمام بدور مضادات الأكسدة في تغذية الانسان خصوصا المرتبطة بالتأثيرات الصحية.وتعتبر ثمار الطماطم مصدر غني بمضادات الأكسدة .وتشبه ثمار الحرنكش ثمار الطماطم الي درجة كبيرة من حيث المظهر والنكهة في حين تمتاز ثمار الحرنكش عن ثمار الطماطم بالطعم الواضح المميز والفوائد الصحية معنويا لانها أعلي في مضادات الاكسدة والفيتامينات والمعادن. ولذلك تهدف هذه الدراسة استكشاف تاثير استبدال عصير ثمار الطماطم بنسب (٢٥- ٥٠ – ٧٥ – ١٠٠%) بعصير ثمار الحرنكش علي مستوى المركبات النشطة حيويا وخواص ومعايير الجودة للكاتشب المصنع. ولقد ظهرت النتائج أن عصير ثمار الحرنكش الطازج يحتوي علي مواد صلبة كلية ثلاث اضعاف مقارنة بما يحتويه عصيرثمار الطماطم الطازج.وايضا كان عصير ثمار الحرنكش اعلي في الحموضة (١.٩٤%) والاس الهيدروجيني(٣.٢٨) مقارنة ٠.٥١% حموضة و٤.٢ اس هيدروجيني في عصيرثمار الطماطم. في حين احتوي عصير الطماطم علي محتوي اقل من البروتين والدهون والكربوهيدرات والالياف والرماد. وعلي الجانب الأخر احتوي عصير ثمار الحرنكش علي كمية أعلي بدرجة معنوية من الفينولات والفلافونيدات وفيتامين ج وبالتالي في النشاط المضاد للأكسدة.وعموما كانت الكاتشب المصنع بنسبة ١٠٠% من عصير ثمار الحرنكش أعلي معنويا في الدهون و الكربوهيدرات والالياف والرماد في حين كان اقل معنويا في البروتين، بينما لا يوجد اختلاف معنوي في الأس الهيدروجيني والحموضة في الكاتشب المصنع بنسبة ١٠٠% من عصير ثمار الحرنكش مقارنة بالكاتشب المصنع بنسبة ١٠٠% من عصيرثمار الطماطم. وبزيادة نسب الاستبدال من عصير الطماطم بعصير ثمار الحرنكش حسنت معنويا في مستويات الفينولات الكلية و الفلافونيدات وفيتامين ج ونتيجة لذلك زيادة في النشاط المضاد للأكسدة في الكاتشب المصنع. وتم قبول المنتج لدي المحكمين بنسب استبدال حتي ٧٥%.

الكلمات المفتاحية: الكاتشب ، التوت الذهبي ، المركبات النشطة حيويا ، الفينول ، الفلافونويد ، حمض الأسكوربيك.