# COMPARISON OF THE NUTRITIVE VALUE OF EVA F1 HYBRID TOMATOFRUIT WITH COMMERCIAL TOMATO PASTES

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***Abstract***
*Tomato (Solanum lycopersicum) is used in soups, stews and sauces. Currently, the trend in the urban areas is the use of processed tomato (tomato paste) in the diet. Eva F1 hybrid (EF1H) tomato is a hybrid that has been shown to be devoid of the challenges of the natural tomato and is now being cultivated and introduced into the market for consumption, especially in Africa. The study is designed to compare the phytochemical, macronutrient and micronutrient content of EF1H and commercial tomato pastes.*
*EF1H tomato fruit were authenticated and obtained from National Horticultural Research Institute, Nigeria. Five different commercial tomato pastes were labeled Pastes A, B, C, D and E.*
*Proximate, phytochemical and micronutrient analyses were conducted using standard methods of Association of Official Analytical Chemists.*
*Proximate analysis showed that the EF1H tomato fruit contain higher levels of crude protein (15.00±0.29%), crude fibre (9.87±0.10%) and moisture content (88.60±0.00%) while the commercial tomato pastes had higher levels of carbohydrate, fat, ash and dry matter. Phytochemical analysis revealed that the commercial tomato pastes contained higher levels of flavonoids, carotenoids, phenolics, lycopene and β-carotene. The commercial tomato pastes had a higher amount of fat soluble vitamins, macro and micro minerals while the fruits had higher levels of the water soluble vitamins with the exception of vitamins $B_9$ and $B_{12}$.*
*EF1H should be used in combination with commercial tomato pastes in the diet.*

**Key words**: Eva F1 hybrid tomato fruit, commercial tomato paste, proximate analysis, vitamins, minerals, phytochemical analysis

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## INTRODUCTION

Tomato (*Solanum lycopersicum*), of the family Solanaceae, is the second most produced and consumed vegetable worldwide and it is a rich source of lycopene, beta-carotene, folate, potassium, vitamin C, flavonoids, and vitamin E(Gerszberg*et al.*, 2015; Gupta, 2011).It is a major part of the diet, especially, in the rural areas in Nigeria. It is also used in salad and to garnish foods like barbecued beef or chicken in urban areas. Currently, it has been found with the discovery of lycopene to have anti-cancer and antioxidative properties(Gerszberg*et al.*, 2015). However there are draw-backs. It takes time between planting and for it to be harvested. It cracks easily when ripe and the yield varies (Vinje, 2019; Glen 2013).

Recent advances in agricultural technology has resulted in the production of hybrids which are a type of genetically modified foods but not in the laboratory. The hybrids are usually as a result of a cross between varieties or generations of a plant. This has been employed in breeding of tomato to produce improvement in yield and fruit quality (Alwis*et al.*, 2008).

Eva F1 is an indeterminate hybrid variety of tomato with the fruit having weight ranging from 110 – 150g(www.plantechkenya.com, 2018). It is characterized by extended shelf life and good resistance to cracking. It exhibits the stacking growing system, flower setting at high temperatures and the growth is enhanced by green house / net house production (https://www.futa.edu.ng). It usually has higher number of seed per fruit, and a high breeding potential for yield, number of fruits per plant and average fruit weight in some of the hybrids(Ganeva, 2011; Hernandez-Leal *et*

*al*., 2018). Currently, conventional lifestyle which includes the ease of achieving tasks with minimal effort and within a short period to give time for other assignments or what can be defined as multitasking, has resulted in the increase in the use of commercial tomato pastes in the diet in place of the fresh tomato fruit. Since Eva F1 hybrid has being introduced into the country, investigation into its advantage in comparison with available commercial tomato pastes becomes imperative and would serve to contribute to the existing knowledge on the nutritive content of Eva F1 hybrid tomato fruit.
This study is designed to compare the nutritive value of Eva F1 hybrid tomato fruit with that of commercial tomato pastes.

## MATERIALS AND METHODS

Eva F1 hybrid (EF1H) tomatofruits were authenticated and obtained from the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria. The weight of the tomato fruits harvested was 1.7kg. Five commercial tomato pastes were obtained from Agbeni market, Ibadan, Oyo State, Nigeria and labelled Pastes A, B, C, D and E with expiry dates within at least a year from the date of purchase. Further details about the pastes can be requested from the corresponding author.

**Preparation of materials**

The tomato fruits were rinsed with distilled water, cut into small pieces and milled with a food processor. The commercial pastes were emptied into universal bottles and labelled.

**Reagents**

The reagents were either products of Fischer Scientific (New Jersey) or MRS Scientific (U.K) and this includes hydrochloric acid, butyl alcohol, 2,4-dinitrophenyl hydrazine, sodium hydroxide and potassium bromide. Hydrochloric acid was handled in the fume cupboard.

**Proximate analysis**

Samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (A.O.A.C.)(2005)for moisture content, crude protein, ash content, fat, crude fibre, carbohydratesand dry matter.

**Phytochemical analysis**

Lycopene and β-carotene were estimated spectrophotometrically using the method derived by Masayasu and Yamashita(1992). The phenolics content was determined by the method of Kim *et al.*(2003). Flavonoids and carotenoids content were determined by the method of Park *et al.*(2008).

**Determination of mineral content**

Phosphorus was determined spectrophoto-metrically using Vanadomolybdate(Yellow) method(A.O.A.C., 1970). Sodium, calcium, and potassium were analyzed according to the official methods of analysis described by A.O.A.C.(2005). Selenium, magnesium, lead, copper, manganese, iron, iodine, zinc and arsenic were determined using Buck 200 Atomic Absorption Spectrophotometer (AAS) (East Norwalk, Connecticut). Determination of sulphur was conducted using the method of American Public health Association and American water works Association(1946).

**Determination of Fat soluble vitamins**

The official methods of analysis described by the Association of Official Analytical Chemist(2005) were employed for the analysis of vitamins A, D and E while the method of Eitenmiller and Landen(1999)was adopted for the determination of vitamin K.

**Determination of Water soluble vitamins**

The method of Eitenmiller and Landen(1999) was employed for the determination of vitamins $B_1$, $B_5$,$B_9$, $B_{12}$ and C. The official methods of analysis described by the Association of Official Analytical Chemist(2005) were employed for the analysis of vitamins $B_2$, $B_3$ and $B_6$.

**Statistical Analysis**

All data are mean ± standard error of mean of triplicates for each parameter. One way Analysis of Variance (ANOVA) was used to compare the differences between the sample means and the control and Least Significant Difference (LSD) was carried out as follow-up. *P-value* was taken to be less than 0.05. The Statistical Package for Social Sciences (IBM SPSS) Version 25.0 software was used for the analysis.

## RESULTS AND DISCUSSION

Moisture aids digestion and the absorption of food. In the proximate analysis (Tables 1 & 2), the percentage moisture content reduced significantly (*$p<0.05$*)in the commercial tomato pastes compared to the EF1H tomato fruit (Table 1). This implies that the EF1H tomato fruit contains higher amount of water compared to the commercial tomato pastes. The reason for this may be because the commercial tomato pastes are concentrated.

EF1H tomato fruit contains significantly (*$p<0.05$*)higher percentage of crude protein (15.00±0.29%) and crude fibre(9.87±0.10%) compared to the commercial tomato pastes (Table 1). Protein is a macronutrient responsible for body building functions(Nelson and Cox, 2017). EF1H may help to serve this purpose. Crude fibre consists of non digestible carbohydrates such as inulin, cellulose and lignin that are intrinsic and intact in plants. It is known to lower rates of coronary heart disease, colon cancer and type 2 diabetes, and aid digestion(Dhingra*et al.*, 2012; Soliman, 2019). Since EF1H contains more crude fibre,it would serve to help these health conditions and adequately enhance digestion (Table 1).

Crude protein and crude fibre in the commercial tomato pastes may have been degraded during thermal processing. The degradation of crude protein and crude fibre may lead to the reduction in the bioavailability or the amount of crude protein and crude fibre in the commercial tomato pastes.

The percentage of ash increased significantly (*$p<0.05$*)in Pastes B (16.95±0.06%) and D (15.36±0.26%), compared to that of the EF1H tomato fruit (14.59±0.15%) (Table 1). This suggests that Pastes B and D could contain more inorganic minerals than the EF1H tomato fruit. These inorganic minerals play important roles in several biochemical processes in the body, including enzyme catalysis and oxygen transportation(Soetan*et al.*, 2010).

Fat in the diet supplies more energy than carbohydrates when ingested and it also possesses fat soluble vitamins (A, D, E and K) and essential fatty acids such as linoleic and linolenic acids(Nelson and Cox, 2017). Fat also plays a vital role in maintaining healthy skin and hair, insulating body organs against shock, maintaining body temperature, and promoting healthy cell function(Shirma, 2017). The percentage fat increased significantly (*$p<0.05$*)in Pastes A (1.33±0.03%), C (1.77±0.06%), D (1.53±0.02%) and E (2.11±0.04%) compared to that of EF1H tomato fruit (1.04±0.06%) (Table 2). This suggests that the commercial tomato pastes (A,C,D, and E) have higher fat content compared to the EF1H tomato fruit and may therefore provide more energy than the tomato fruit and possess the essential fatty acids and fat soluble vitamins.

Dry matter is an indication of nutrients available in the diet(Parish, 2007). The percentage dry matter increased significantly in the tomato pastes compared to that of the EF1H tomato fruit (11.40±0.00%) (Table 2).

Thus suggesting that the commercial pastes have significant amount of nutrients and it may also be as a result of the pastes being concentrated.

**Table 1:** Proximate analysis of Eva F1 hybrid tomato fruit andcommercial tomato pastes

| SAMPLE | MOISTURE CONTENT (%) | CRUDEPROTEIN (%) | CRUDEFIBRE (%) | ASH (%) |
|---|---|---|---|---|
| **EF1H** | 88.60±0.00 | 15.00±0.29 | 9.87±0.10 | 14.59±0.15 |
| **PASTE A** | 71.91±0.01* | 7.63±0.13* | 0.72±0.01* | 8.63±0.13* |
| **PASTE B** | 73.31±0.31* | 6.08±0.02* | 0.76±0.01* | 16.95±0.06* |
| **PASTE C** | 74.20±0.20* | 7.98±0.03* | 0.94±0.08* | 12.00±0.10* |
| **PASTE D** | 73.61±0.01* | 6.38±0.02* | 1.14±0.03* | 15.36±0.26* |
| **PASTE E** | 74.23±0.12* | 8.29±0.10* | 0.99±0.04* | 13.31±0.09* |

Note: * **-** significant at *$p< 0.05$*; all data are mean±standard error of mean of triplicates

**Table 2:** Other proximate analysis of Eva F1 hybrid tomato fruit and commercial tomato pastes

| SAMPLE | FAT (%) | DRYMATTER (%) | CARBOHYDRATE (%) |
|---|---|---|---|
| **EF1H** | 1.04±0.06 | 11.40±0.00 | 59.54±0.60 |
| **PASTE A** | 1.33±0.03* | 28.09±0.01* | 81.68±0.16* |
| **PASTE B** | 1.13±0.03 | 26.69±0.31* | 75.07±0.08* |
| **PASTE C** | 1.77±0.06* | 25.78±0.22* | 77.31±0.15* |
| **PASTE D** | 1.53±0.02* | 26.38±0.01* | 75.58±0.28* |
| **PASTE E** | 2.11±0.04* | 25.77±0.12* | 75.30±0.00* |

Note: * - significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

Carbohydrate is a macro nutrient that makes energy available to the body(Zimmerman and Snow, 2012; Nelson and Cox, 2017). The percentage carbohydrate increased significantly ($p<0.05$)in the commercial pastes compared to the EF1H tomato fruit (59.54±0.60%) (Table 2). This suggests that the commercial tomato pastes (Pastes A, C, D and E) have higher carbohydrate content compared to the tomato fruit and may provide more energy than the EF1H tomato fruit.

The bioactivities of plants are as a result of their active phytochemical constituents which elicit physiological and biochemical actions on the human body(Ekpo*et al*., 2013). These phytochemical constituents include lycopene, carotenoids, flavonoids, phenolics and β-carotene. These phytochemical constituents are potential antioxidants which reduce oxidative stress(Zhang *et al*., 2015). Oxidative stress is responsible for aging and several diseases such as; prostate cancer, cardiovascular diseases and colon cancer. Flavonoids, phenolics, lycopene and other carotenoids are known for their antioxidant activities towards inhibiting free radical reactions(Lee *et al*., 2017). From the phytochemical analysis(Table 3), the commercial tomato pastes contain more antioxidants than the EF1H tomato fruit because of significantly ($p<0.05$)higher levels of lycopene, carotenoids, flavonoids, phenolics and β-carotene. The commercial pastes can therefore be relevant to managing health challenges as a result of oxidative stress.

For the macro mineral analysis (Tables 4), calcium is vital for the formation of strong bones and teeth, as well as muscle contraction amongst other roles it plays in the body(Institute of Medicine, 2011). The percentage calcium increased significantly($p<0.05$)in the commercial tomato pastes compared to the hybrid tomato fruit (0.01±0.00%) with Paste B (0.05±0.00%) being the highest (Table 4). This suggests that commercial tomato pastes contain more percentage calcium compared to the tomato fruit and will therefore be good sources of calcium.

Magnesium is needed for over 300 biochemical reactions in the body (Laguipo, 2019). The percentage magnesium increased significantly ($p<0.05$)in the commercial pastes compared to the tomato fruit thus making the commercial pastes vital for the process of various biochemical reactions needed for proper body function (Table 4).

**Table 3:** Phytochemical Constituents of Eva F1 Hybrid tomato fruit and commercial tomato pastes

| SAMPLE | Flavonoids (mg/g) | Phenolics (mg/g) | Carotenoids (mg/100ml) | Lycopene (mg/100ml) | Beta-carotene (µg/100g) |
|---|---|---|---|---|---|
| **EF1H** | 0.10±0.04 | 0.23±0.09 | 1.34±0.11 | 0.10±0.01 | 453.56±0.02 |
| **PASTE A** | 0.42±0.04* | 0.92±0.09* | 5.86±0.11* | 0.51±0.01* | 492.82±0.02* |
| **PASTE B** | 0.41±0.04* | 0.88±0.09* | 1.09±0.11* | 0.08±0.01* | 487.35±0.02* |
| **PASTE C** | 0.44±0.04* | 1.44±0.09* | 7.31±0.11* | 0.63±0.01* | 492.56±0.02* |
| **PASTE D** | 0.62±0.04* | 2.11±0.09* | 7.96±0.11* | 0.67±0.01* | 487.64±0.02* |
| **PASTE E** | 0.47±0.04* | 1.58±0.09* | 5.75±0.11* | 0.48±0.01* | 487.18±0.02* |

Note: * - significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

**Table 4:** Profile of macro minerals content in Eva F1 hybrid tomato fruit and commercial tomato pastes

| SAMPLE | P (%) | Ca (%) | Mg (%) | K (%) | Na (%) | Sulphur (mg/100g) |
|---|---|---|---|---|---|---|
| **EF1H** | 0.56±0.00 | 0.01±0.00 | 0.01±0.00 | 0.09±0.00 | 0.01±0.00 | 5.67±0.33 |
| **PASTE A** | 0.56±0.00 | 0.03±0.00* | 0.02±0.00* | 0.28±0.00* | 0.24±0.01 | 9.33±0.67* |
| **PASTE B** | 0.55±0.00 | 0.05±0.00* | 0.02±0.00* | 0.25±0.01* | 0.62±0.01* | 12.33±1.45* |
| **PASTE C** | 0.56±0.00 | 0.03±0.00* | 0.03±0.00* | 0.44±0.01* | 0.23±0.01 | 13.33±1.67* |
| **PASTE D** | 0.56±0.00 | 0.04±0.00* | 0.03±0.00* | 1.16±0.03* | 1.43±0.23* | 10.00±1.16* |
| **PASTE E** | 0.57±0.00 | 0.04±0.00* | 0.02±0.00* | 0.36±0.00* | 0.25±0.00 | 11.00±0.58* |

Note: * **-** significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

Potassium plays several roles including regulating nerve signals and fluid balance(Cowan, 2016). The percentage potassium increased significantly ($p<0.05$)in the commercial pastes compared to the hybrid tomato fruit (0.09±0.00%) with Paste D (1.16±0.03%) being the highest (Table 4). This suggests that potassium is more available in commercial tomato pastes compared to the tomato fruit.

Sodium is responsible for normal nerve and muscle function(Healthwise, 2018). The level was increased in all the commercial pastes with significance ($p<0.05$)in pastes B (0.62±0.01%) and D (1.43±0.23%), though all the commercial pastes are fortified with salt (sodium chloride) and can therefore facilitate transmission of nerve impulses and muscle excitation (Table 4).

Sulphur is responsible for insulin function and is present in glutathione (an important antioxidant)(Weiss *et al.*, 2014). The amount of sulphur increased significantly($p<0.05$) in the commercial pastes compared to the EF1H tomato fruit (Table 4). This suggests that sulphur in commercial tomato pastes can help the function of insulin and aids the scavenging of free radicals.

For the trace mineral analysis (Tables 5 & 6), the iron content increased significantly ($p<0.05$) in Pastes B (136.83±0.60 mg/kg) and E (112.83±0.17 mg/kg) compared to the EF1H tomato fruit (108.00±1.15 mg/kg) (Table 5). Iron is important for blood formation and in particular the function of hemoglobin and myoglobin, the deficiency of which results in anemia(Abbaspour*et al.*, 2014). Pastes B and E may be good sources of iron and therefore prevent anemia.

Copper facilitates iron uptake thereby preventing anemia and neutropenia(reviewed in Nose *et al.*, 2006). The level of copper was significantly ($p<0.05$)higher in Pastes C (1.50±0.00 mg/kg), D (1.47±0.03 mg/kg) and E (1.53±0.03 mg/kg) compared to the EF1Htomato fruit (1.00±0.00 mg/kg) (Table 5). This suggests that copper in Pastes C, D and E may enhance red blood cell formation.

Zinc plays a key role in wound healing, cell division and growth as well as in the immune system(Lin *et al.*, 2018). Zinc also plays a role in the functional regulation of the central nervous system thereby decreasing the incidence of neurotoxicity. Its deficiency can play a role in cancer, the aging process and in the etiology of several age-related chronic illnesses such as immune senescence, atherosclerosis and degenerative diseases of the nervous system(Kumar *et al.*, 2016). Pastes B (7.49±0.16 mg/kg), C (8.97±0.12 mg/kg), D (6.90±0.10 mg/kg) and E (6.30±0.08 mg/kg) contain increased significant ($p<0.05$)levels of zinc compared to the EF1H tomato fruit (5.77±0.06 mg/kg) (Table 5). This implies that regular intake of these pastes can help decrease the occurrence of certain age-related chronic diseases and boost the immune system.

The level of lead increased significantly in Pastes A (3.10±0.06 mg/kg), C (4.17±0.12 mg/kg), D (4.50±0.00 mg/kg) and E (4.53±0.27 mg/kg) compared to the EF1H tomato fruit (1.62±0.02 mg/kg) (Table 5). Lead is a highly poisonous metal, which when ingested in significant amounts, affects the organs and

systems in the human body such as the brain, kidney and the central nervous system, thereby decreasing neuronal growth(Hsiang and Diaz, 2011). The data show that the EF1H tomato fruit is safer than some of the commercial tomato pastes in this regard.
The level of manganese increased significantly (*p<0.05*)in the commercial tomato pastes compared to the EF1H tomato fruit (Table 6). Manganese plays an important role in bone formation and activates many enzymes in carbohydrate and cholesterol metabolism, and is an important component of the Mn-superoxide dismutase which helps to scavenge reactive oxygen species in the mitochondrion(Li and Yang, 2018). The commercial pastes will be beneficial in aiding the metabolic process in the body and the regulation of oxidative stress in the mitochondrion.
Iodine is essential for the proper function of the thyroid gland and therefore to prevent goiter(Chung, 2014). The level of iodine increased significantly in all the commercial pastes compared to the EF1H tomato fruit (Table 6). This suggests that these commercial pastes can enhance the proper function of the thyroid glands and therefore prevent the occurrence of goiter.Selenium is also important for proper thyroid function and therefore affects metabolism. It helps to protect the body from oxidative stress and improve immune response(Rocourt*et al.*, 2011; Mullur*et al.*, 2014). The amount of selenium increased significantly in the commercial tomato pastes compared to the EF1H tomato fruit and may therefore help to prevent disease as a result of oxidative stress and also boost immune response (Table 6).
There are two types of arsenic: organic and inorganic. Organic arsenic is found in diet and is less toxic than inorganic arsenic. Long-term exposure to arsenic has been reported to be responsible for high rates of heart disease, skin cancer, lung cancer and bladder cancer(Hughes *et al.*, 2011). However, arsenic has been shown in animals to be involved in the metabolism of methionine, gene expression, growth and reproduction. The amount of arsenic increased significantly (*p<0.05*)inall the commercial pastes compared to the hybrid tomato fruit (Table 6). The increased levels of lead and arsenic in the commercial pastes may be as a result of the exposure of the pastes to the machines during production. However, the levels are not toxic.

**Table 5:** Profile of trace minerals in Eva F1 hybrid tomato fruit andcommercial tomato pastes

| SAMPLE | Fe (mg/kg) | Cu (mg/kg) | Zn (mg/kg) | Pb (mg/kg) |
|---|---|---|---|---|
| EF1H | 108.00±1.15 | 1.00±0.00 | 5.77±0.06 | 1.62±0.02 |
| PASTE A | 96.67±0.67* | 0.77±0.02* | 5.58±0.11 | 3.10±0.06* |
| PASTE B | 136.83±0.60* | 0.82±0.02* | 7.49±0.16* | 1.07±0.07* |
| PASTE C | 98.33±0.67* | 1.50±0.00* | 8.97±0.12* | 4.17±0.12* |
| PASTE D | 85.00±1.00* | 1.47±0.03* | 6.90±0.10* | 4.50±0.00* |
| PASTE E | 112.83±0.17* | 1.53±0.03* | 6.30±0.08* | 4.53±0.27* |

Note: *- significant at *p< 0.05*; all data are mean±standard error of mean of triplicates

**Table 6:** Profile of other trace minerals in Eva F1 hybrid tomato fruit and commercial tomato pastes

| SAMPLE | Mn (mg/kg) | I (mg/kg) | Se (mg/kg) | As (mg/kg) |
|---|---|---|---|---|
| EF1H | 0.54±0.03 | 0.43±0.01 | 0.01±0.00 | 0.14±0.00 |
| PASTE A | 2.07±0.03* | 5.53±0.09* | 0.02±0.00* | 0.29±0.00* |
| PASTE B | 2.08±0.04* | 3.70±0.12* | 0.03±0.00* | 0.25±0.00* |
| PASTE C | 1.55±0.03* | 4.37±0.15* | 0.03±0.00* | 0.27±0.00* |
| PASTE D | 2.04±0.02* | 5.13±0.12* | 0.04±0.00* | 0.27±0.00* |
| PASTE E | 1.07±0.04* | 3.27±0.09* | 0.04±0.00* | 0.26±0.00* |

Note: *- significant at *p< 0.05*; all data are mean±standard error of mean of triplicates

**Table 7:** Fat soluble vitamins constituent of Eva F1 Hybrid tomato fruitand commercial tomato pastes

| SAMPLE | Vitamin A (µg/100g) | Vitamin D (µg/100g) | Vitamin E (µg/100g) | Vitamin K (µg/100g) |
|---|---|---|---|---|
| **EF1H** | 41.87±0.01 | 0.16±0.01 | 0.10±0.01 | 0.26±0.01 |
| **PASTE A** | 98.42±0.02* | 0.69±0.01* | 0.35±0.01* | 0.65±0.01* |
| **PASTE B** | 92.41±0.02* | 0.46±0.01* | 0.23±0.01* | 0.51±0.01* |
| **PASTE C** | 96.79±0.02* | 0.56±0.01* | 0.18±0.01* | 0.57±0.01* |
| **PASTE D** | 95.71±0.01* | 0.52±0.01* | 0.21±0.01* | 0.59±0.01* |
| **PASTE E** | 91.59±0.01* | 0.39±0.02* | 0.29±0.01* | 0.46±0.01* |

Note: * - significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

The fat soluble vitamins A, D, E and K were increased significantly ($p<0.05$)in the commercial tomato pastes compared to the EF1H tomato fruit (Table 7). Vitamin A is responsible for good vision and prevents incidence of night blindness(Gilbert, 2013). Vitamin D helps in calcium absorption and promotes bone growth in the body and therefore prevents the incidence of ricket and osteomalacia. Vitamin E is an antioxidant which has been shown to reduce neuroinflammation, osteoporosis and the onset of cardiovascular diseases(Tan*et al.*, 2018). Vitamin K plays a vital role in regulating cell growth, blood calcium levels, blood clotting, and bone metabolism and strength(Vermeer, 2012; Maresz, 2015). The deficiency leads to excessive bleeding. The commercial tomato pastes have the potential to ameliorate all these disease conditions as a result of a deficiency in any of the fat soluble vitamins regardless of fortification in a few of the pastes.

The water soluble vitamins $B_1$, $B_2$, $B_3$, $B_5$, $B_6$, $B_9$, $B_{12}$ and C play vital roles in the body which include aiding the proper functioning of the digestive and nervous systems, metabolism of macro nutrients, muscle function, production of genetic material, production of red blood cells, mental health, proper formation of fetus' nervous system, healthy skin, protection against heart disease and proper heart function(Fenech 2012; Mahmood 2014; Sampedro*et al.*, 2015; Gasperi*et al.*, 2019; Martel and Franklin, 2019). With the exception of vitamins $B_9$ (folic acid)and$B_{12}$(cobalamin), all the other water soluble vitamins analyzed were significantly ($p<0.05$)reduced in the commercial tomato pastes compared to the EF1H tomato fruit (Tables8 & 9). Folic acid deficiency is one of the wide spread vitamin deficiencies which results in poor mental health and abnormal formation of the fetus' central nervous system, while cobalamin deficiency results in megaloblastic anaemia (similar to that of folic acid deficiency) and poor neurological function. Regular intake of the commercial tomato pastes may be able to avoid the incidence of these deficiencies.

**Table 8:** Water soluble vitamins constituent of the Eva F1 hybrid tomato fruitand commercial tomato pastes

| SAMPLE | Vitamin $B_1$ (mg/100g) | Vitamin $B_2$ (mg/100g) | Vitamin $B_3$ (mg/100g) | Vitamin $B_5$ (mg/100g) | Vitamin C (mg/100g) |
|---|---|---|---|---|---|
| **EF1H** | 0.10±0.01 | 0.08±0.01 | 0.04±0.00 | 1.22±0.01 | 31.97±0.09 |
| **PASTE A** | 0.04±0.01* | 0.01±0.00* | 0.03±0.00* | 0.24±0.01* | 22.43±0.09* |
| **PASTE B** | 0.03±0.00* | 0.01±0.00* | 0.02±0.00* | 0.26±0.01* | 25.60±0.12* |
| **PASTE C** | 0.04±0.00* | 0.03±0.00* | 0.01±0.00* | 0.13±0.01* | 15.73±0.09* |
| **PASTE D** | 0.03±0.01* | 0.02±0.00* | 0.03±0.00* | 0.35±0.03* | 14.70±0.12* |
| **PASTE E** | 0.05±0.00* | 0.04±0.00* | 0.03±0.01* | 0.40±0.03* | 18.33±0.09* |

Note: *- significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

**Table 9:** Other water soluble vitamins constituent of the Eva F1 hybrid tomato fruit andcommercial tomato pastes

| SAMPLE | Vitamin $B_6$ (mg/100g) | Vitamin $B_9$ (mg/100g) | Vitamin $B_{12}$ (mg/100g) | Vitamin C (mg/100g) |
|---|---|---|---|---|
| **EF1H** | 0.02±0.00 | 0.05±0.00 | 0.01±0.00 | 31.97±0.09 |
| **PASTE A** | 0.02±0.00 | 0.08±0.00* | 0.03±0.00* | 22.43±0.09* |
| **PASTE B** | 0.03±0.00 | 0.06±0.00* | 0.01±0.00 | 25.60±0.12* |
| **PASTE C** | 0.02±0.00 | 0.06±0.00* | 0.02±0.00 | 15.73±0.09* |
| **PASTE D** | 0.01±0.00* | 0.08±0.00* | 0.04±0.00* | 14.70±0.12* |
| **PASTE E** | 0.01±0.00* | 0.07±0.00* | 0.03±0.00* | 18.33±0.09* |

Note: *- significant at $p< 0.05$; all data are mean±standard error of mean of triplicates

## CONCLUSION

The study shows that Eva F1 hybrid tomato fruit is rich in water soluble vitamins while the commercial pastes, which are derived from other types of tomato like San Marzano, Roma etc., have appreciable contents of essential nutrients including phytochemicals and the fat soluble vitamins. A combination of both sources in the diet would help in facilitating adequate intake of some nutrients in the diet.

## RECOMMENDATION

The employment of other safe materials in the fabrication of the machines used in the processing of the commercial tomato pastes can be designed to remove contamination with lead and arsenic.

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