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INFLUENCE OF ORGANIC AND MINERAL FERTILIZERS ON CHEMICAL AND BIOCHEMICAL COMPOUNDS CONTENT IN TOMATO (*Solanum lycopersicum*) VAR. MONGAL F1

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ABSTRACT

The concentration of secondary metabolites can be influenced qualitatively and quantitatively by ecological factors and farming practices. The purpose of this study was to determine the impact of organic and mineral fertilization on physical characteristics and the content of chemical and biochemical compounds of the fruits of the tomato var. Mongal F1. Physical, chemical and biochemical characterizations of tomato samples were carried out from samples collected from control, organic and mineral fertilized plants, to assess the nutritional potential according to fertilization. Samples collected from the organic fertilizer had pH values of 4.21 ± 0.01 corresponding to measurable acidity of 8.47 ± 0.06 g malic acid /100g Fresh Tomato (FT), dry matter of 4.18 ± 0.02 /100g FT and total ash content of 0.38 ± 0.01 /100g FT. The contents of fats, proteins are respectively 2.28 ± 0.01 and 0.70 ± 0.02 mg/100g FT, totals sugar value of 2.83 ± 0.02 mg/100g FT. For mineral fertilization, the samples had pH values of 4.16 ± 0.01 corresponding to a measurable acidity of 8.10 ± 0.12 g malic acid /100g FT, values of dry matter 3.82 ± 0.02 /100g FT and totals ash content of 0.37 ± 0.01 . The contents of fats and proteins are respectively 0.27 ± 0.01 and 0.64 ± 0.01 mg/100g FT with totals sugar value of 2.56 ± 0.01 mg/100g FT. Result of study revealed that organic fertilization can increase the concentration of secondary metabolites production in tomato var. Mongal F1 than mineral fertilization. This increase may be probably due to the availability of various major and minor elements in organic fertilizer contrary to mineral fertilizer which has only three major elements, Nitrogen (N), Phosphorus (P) and Potassium (K). Globally fruit ripping has shown a positive effect on the accumulation of fats, proteins and total sugar.

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1 Introduction

Many epidemiological studies revealed the beneficial effects of fruit and vegetables on human health and avoiding chronic diseases such as cardiovascular disease including risk factors such as hypertension, diabetes, obesity and prevent also esophageal, stomach, pancreatic bladder and cervical cancers (Van Duyn & Pivonka, 2000; Crawford et al., 1994; Oguntibeju et al., 2013). These studies demonstrated that - fruits and vegetables have various nutrients such as carotenoids, phenolic compounds, vitamins, minerals, sulfur compounds which are associated with beneficial outcomes related to diseases cures (Wargovich, 2000; Chanforan, 2011). High consumption of tomatoes and tomato products have been associated with the reduction of carcinogenesis, especially prostate cancer and it may be due to the presence of lycopene, which give red color to the tomato (Giovannucci et al., 2002; Boileau 2003). Fruit contributes to a healthy and balanced diet rich in minerals (iron, phosphorus), vitamins (C, B), essential amino acids, sugars as well as dietary fiber (Chanforan, 2011). Further, Tohill et al. (2004) suggested that fruits and vegetable intake have positive effect on weight management and obesity prevention. The biochemical composition of tomato fruit varies according to the variety, environmental factors such as light, temperature, fertilization and farming practices (Dorai et al., 2001).

Yanar et al. (2011) evaluated the effects of different organic fertilizers on yield and fruit qualities of indeterminate tomato and reported satisfactory increases in the tomato yield and quality in plant treated by organic fertilizers. Similar results were reported by Suge et al. (2011) when they studied the effect of organic or inorganic fertilizers on the egg plant. Finding of Tonfack et al. (2009) are contradictory to the findings of Yanar et al. (2011) and Suge et al. (2011). Tonfack et al. (2009) studied the effect of individual or combined application of organic or mineral fertilizer on tomato plant growth and fruit P, K, Ca and Na contents and reported no major difference between the organic and mineral fertilizer. Further these researchers were not reported any significant effect of fertilizer application on the tomato fruit P, K, Ca and Na content.

Çolpan et al. (2013) determined the effects of potassium on the yield and yield components of tomato grown in greenhouse conditions and reported a significant effect of potassium application on the final yield of tomato crops. They also reported dose depended effect on the plant stem diameter, plant length, fruit diameter, fruit number, fruit weight, penetration resistance and sugar content. In addition, the leaf N/K ratio also affected the tomato yield. Contrary observation was reported by Makinde et al. (2016), these researcher reported lower potassium content in the plot treated by NPK plots as compare to control but not different statistically from each other. Combined applications of mineral and organic fertilizer have higher sodium content as compared to individual application. Information regarding the effect of organic or

mineral fertilizers on the Burkina Faso local varieties of tomato Mongal F1 is in scarcity. The purpose of the present study is to determine the influence of organic and mineral fertilizers on the physical, chemical and biochemical characteristics of the variety of tomato Mongal F1 at different fruit rippling stages.

2 Materials and Methods

This experiment was conducted in the greenhouse of the National Research Center (12°25'N, 1°29'W) in Burkina Faso. The site was flat, with an elevation of 435m above sea level (IGB, 2014).

2.1 Plant Materials

Plant materials used in this study was the local variety of tomato var., Mongal F1 which was obtained from INRA (France). This variety was adapted for the dry and hot weather in Burkina Faso. It is also resistant to nematodes and some bacterial and fungal diseases (Aïssa et al., 2014). The organic fertilizer used in this study was well-decomposed livestock manure and the mineral fertilizers were N-P-K (23-14-23).

2.2 Experimental design and studied factors

Study was conducted in factorial randomized block design and each treatment was replicated four times. Farming operations were carried out by following the user manual instructions proposed for the variety. Two factors studied in this study were type of fertilizer and harvesting period. Effect of three sources of fertilizers viz. Organic Fertilization (OF); Mineral Fertilization (MF) and Control (C) in combination with three harvesting periods i.e. R1 (79 DAP- Days After Planting), R2 (85 DAP) R3 (89 DAP) were studied. Nine factorial combinations which were formulated in this study are C/R1, C/R2, C/R3, OF/R1, OF/R2, OF/R3, MF/R1, MF/R2, and MF/R3. Spacing between blocks was 2.5 m and elementary plots were 1.5 m apart. Each plot consisted of 4 rows of 3 m in length. Spacing between adjacent rows was 0.8 m and plants within each row were 0.5 m apart. Two border lines were planted on both sides in each plot to reduce border effects. Effect of these factors was studied on the physiological maturity, chemical and biochemical characteristics of the tomato fruits.

2.3 Physical and Chemical analysis

2.3.1 Determination of dry matter, pH, total ash content and titratable acidity

The dry matter is determined by differential weighing before and after heating at 70°C in the oven by following the method of NF V03-707 (2000). Measurements of tomato purees pH were carried out by pH-meter (HI 8520, Hanna Instruments, France). The ashes were obtained according to the International Standard ISO 2171 (2007), by differential weighing of samples before and after drying. The ash content

(mineral) is estimated by incineration in an oven at 550°C so as to obtain all of the cations in the form of carbonate or other anhydrous inorganic salts. The titratable acidity is the content of organic and inorganic acids, determined by titration according the European Standard EN 12147 of December (1996) and NF V 05-101, January (1974). The principle of the method is based on potentiometric titration of an aqueous solution of tomato purees with sodium.

2.3.2. Biochemical analysis

2.3.2.1 Determination of total lipids

Total fat content was determined by Soxhlet extraction method by using hexane as extraction solvent by following the guide line proposed by International Standard ISO 659 (1998).

2.3.2.2 Determination of total sugars

Total sugars were assayed by sulfuric orcinol according to the method described by Montreuil & Spik (1969).

2.3.2.3 Determination of total protein

Total proteins of tomato purees were measured by the differential method according to the formula below.

$$\text{Protein content} = 100 - (\% \text{ humidity} + \% \text{ ash} + \% \text{ fats} + \% \text{ sugar})$$

2.3.2.4 Determination of energy value

The theoretical energy value is calculated using the coefficients of Merrill, adopted by the Southgate & Durnin (1970). With P, C, L, the respective percentages of dry weight of protein, carbohydrates and lipids. The calorific value of the

sample is obtained as follows:

$$\text{Energy value (kcal/100 g FT)} = P \times 4 \text{ kcal} + C \times 4 \text{ kcal} + L \times 9 \text{ kcal}$$

2.4 Statistical analysis

The data were analyzed by factor analysis of variance (ANOVA) with repetitions and the means were separated using Fischer's test at $P = 0.05$. The statistical analysis was performed using XLSTAT software version 7.5.2.

3 Results and Discussion

3.1 Effect of fertilizers application on various physical parameters of tomato var. Mongal F1

3.1.1 pH

All the studied samples are showing pH between 4.15 and 4.30 (Figure 1). These values are similar to those reported by Aoun et al. (2013) who reported pH value between 4.19 and 4.45 in 16 tomato varieties. Further, it was reported that pH values of organic fertilizer are higher than those of mineral fertilization. Acidic pH of tomatoes samples doesn't promote the development of some bacteria but is appropriate for the development of fungal flora (Reynes et al., 1994). The potential of hydrogen is one of the variables used to characterize the middle properties. Its value is correlated to kinetic laws of reactions, the organoleptic qualities of products or enzymatic activities (Boukhiar, 2009). Indeed, this pH level significantly reduces the rate and range of micro-organisms which can promote on the product. Only acidophil micro-organisms, acetic bacteria and lactobacilli can grow, but not coliforms *Escherichia coli* (Messaouda, 2013).

Figure 1 Effect of organic and mineral fertilizer on pH, dry matter, total ash and Titratable acidity of tomato var. Mongal F1

3.1.2 Dry matter content

Dry matter content was reported between 3.63% and 4.54% of the fresh one and this value was reported higher in the plant fertilized by organic manure as compared to the plant fertilized by mineral fertilizer and the control (Fig 1). Dry matter values reported in this study are lower than the findings of Messaouda (2013) those have reported 5.74% of fresh material. This slight difference could be due to the difference in the analysis method or in tomato varieties.

3.1.3 Ash content

No significant difference was reported in the ash contents of various treatments and this parameter varies from 0.33% to 0.39% fresh weight treatment (Fig 1). Like other two parameters, ash contents of samples fertilized by organic fertilizer are higher to those which are fertilized by mineral fertilizer for all the three harvests. This result could be explained by a greater variety of nutrients of organic manure available for plant than mineral fertilizer. The values of the ash content of the present study are lower than those reported by the USDA (2007), which is 0.5% FT. This difference is probably related to factors such as the variety of tomato used and farming practices.

3.1.4 Titratable acidity

Value of titratable acidity varies from 7.72 to 8.81g/100g fresh material and it was reported higher in the plant treated by organic fertilizer and this value was higher for all the plant treated by organic compounds as compared to the plant treated

by mineral fertilizers and control for all the 3 harvests (Fig 1). The values of the titratable acidity of this study are higher than the value reported by Messaouda (2013) who reported 5.74g/100g found in the dried tomato. This difference could be explained by the difference in tomato variety used, but also the fact that the author used powder processed tomatoes.

3.2 Biochemical characteristics

3.2.1 Fats

Lipids value for plant treated by organic and mineral fertilizer are varies between 0.24 and 0.31% FT and the plant fertilized by organic manure have higher fats values than the plant fertilized with mineral fertilizer and control (Fig 2). Ripping has a positive effect on the accumulation of fats for both mineral and organic fertilizers. The values of the lipid content are higher than the value found in the literature, USDA (2007) which is 0.2% FT. This variability may be justified by the difference in various parameters such as the geographical origin of samples and the variety.

3.2.2 Total protein content

Like fat content, value of total proteins content also varies between 0.62 and 0.73% FT (Fig 2). Further, like fat content ripping has a positive impact on the accumulation for both mineral and organic fertilizers. Protein content with mineral fertilizer is lower than the organic manure. These values are lower than those found by USDA (2007) which is 0.88 % FT. This difference could be explained by the difference in variety of present study and it's origin.

Figure 2 Effect of organic and mineral fertilizers on the levels of total lipids, total protein, total sugar and energy value

3.2.3 Total sugar content

Value of total sugars content also varies from 2.33 to 3.14% FT and sample fertilized with mineral fertilizer shows lower total sugars content as compared to organic manure for all the three harvests. Result of study revealed that the level of total sugar increase during fruit maturation. The sugar contents of the present study are similar to those found by Messaouda (2013) and USDA (2007) which is respectively 1.38 and 3.92%. Indeed, the total sugar content is variable, and this variability may be related to the reaction of the non-enzymatic browning (Georgelis et al., 2006; Davoodia et al., 2006).

3.2.4 Energetic value

The energy value of tomato samples varies between 14.45 and 18.02 kcal/100g of fresh material. Samples fertilized with mineral fertilizer presents lower energy values than those fertilized with organic manure. These results are similar to those found by USDA (2007) which is 18 kcal/100g of fresh tomato.

Conclusion

Result of present study revealed that organic fertilizers have positive and stimulating effect on the physical, chemical and biochemical characteristics content of tomato var. Mongal F1. Moreover it was reported that mineral fertilizer does not have any significant effect on various studied parameter and it was not significantly different than the control. For parameters such as pH, fats, acidity, protein and total sugar contents, tomatoes grown with organic manure showed higher values than those of mineral (NPK) fertilizer and fruit ripping has a positive effect on the accumulation of these compounds for both mineral and organic fertilizers.

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Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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