International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 2693-2699

Received: 13-05-2019
Accepted: 15-06-2019

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Studies on carrot and apple blended jam fortified with flaxseed

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Abstract
The present study was to evaluate a suitable combination to check the effect on the quality of carrot, apple and flaxseed blended jam of different treatment. The treatments were T_0(apple(A) + carrot(C) and flaxseed(F) in ratio (100:0), T_1(apple(A) + carrot(C) and flaxseed(F) in ratio (95:5), T_2(apple(A) + carrot(C) and flaxseed(F) in ratio (90:10) and T_3(apple(A) + carrot(C) and flaxseed(F) in ratio (85:15). All the treatments were examined for chemical analysis i.e. ash, Total Soluble Solids (°Brix), moisture percentage, acidity percentage, pH, Total sugars percentage, ascorbic acid (mg/100 g), total antioxidant activity percentage and for microbiological analysis viz. yeast and mould (cfu/gm) and coliform and for sensory properties i.e. colour & appearance, body & texture, flavour & taste and overall acceptability. A significant increase of (p<0.05) was examined in ash from (0.62 to 0.65%), moisture (30.42 to 31.36%), pH (3.19 to 3.27), Total sugar (62.85 to 64.40 %), Total antioxidant activity (0.70 to 0.97) while decrease significantly was examined in TSS (°brix) from 69.58 to 68.64, acidity (0.35 to 0.31%), ascorbic acid (mg) (15.74 to 11.82). Yeast and mould (cfu/gm) count was found from 6.20 to 3.80 and coliform was examined nil. Sensory analysis was studied that T_2 (90:10) was the most liked jam treatment with highest score for nearly all the evaluating parameters.

Keywords: Jam, carrot, apple, flaxseed, sensory, chemical analysis

Introduction
Jams are solid gels made from fruit pulp or juice, sugar and added pectin. Jams are made from single fruits or a combination of fruits. It can be defined as an intermediate moisture food prepared by cooking sugar with fruit pulp, acid, pectin and other ingredients to a sensibly consistency. Jam contains about 65% TSS and at least 45% pulp. Jam are generally two types, the one which is developed from pulp of single fruit and the second type is prepared by blending two or more fruits pulp (Manay SN, Shadaksharaswamy N, 2005) [15].

Carrot (*Daucus carota L*) is one of the popular root vegetables grown throughout the world and is the important source of dietary carotenoids in western countries including the United States of America (Block 1994; Torronen *et al.*, 1996) [3, 25]. Carrot is being perishable and seasonable, it is not possible to readily make it available throughout the year. In the carotenoids such as β-carotene have attracted considerable attention because it has protective effect against some types of cancers (Bast *et al*., 1996; Santo *et al*., 1996; Van 1996) [2, 20, 26]. In human system, the physiological activity of α- (50%) and β-carotene (100%) of the provitamin A activity (Panalaks and Murray 1970; Simpson 1983) [17, 21] and one molecule of β-carotene yields two molecules of retinol in human system. Carotenoids have been enhancement of immune system and decreased risk of degenerative diseases such as cancer, cardiovascular disease, age related mascular degeneration and cataract formation (Mathews-Roth 1985[16]; Faulks and Southon 2001[8].

Apples especially apple peels have been found to have a potent antioxidant activity and can greatly inhibit the growth of liver cancer and colon cancer cells (Wolfe *et al*., 2003)[29]. Apple and pear intake was associated with a decreased risk of asthma and decrease in bronchial hypersensitivity. Apple was used for the presence of phytochemicals that help to reduce certain kinds of disease occurrence. Apple contained water 84.7 %, fiber 0.8g, carbohydrates 13.9g, protein 0.4g, lipid 0.3g, ash 0.3g, vitamin C 8mg, 57 kcal of energy per 100g of edible portion (Hussain, 2001) [11]. Commercial production of apple jam is subjected to standard formulation of fruit pulp, sugar content, adjusted acidity and pectin. It is processed to get ready juices, jams, jelly, canned apple slices and dehydrated apple slices.

In jam and jellies sugar stops growth of microorganisms and prevent spoilage. Sugar holds water due to shelf life of the products is increased (Clarke MA, 1997) [4]. Pectin being a gelling agent is responsible for gel information in the jam preparation (Fu JT and Rao MA 2001) [9]. Stabilizing, thickening and textural characteristics are improved by pectin in different foods such as jam, jelly, beverages, bakery products and confectionery (Wang *et al*., 2002) [28]. Citric acid is also essential to accurate balance for required in jam and jellies preparation.

Flaxseed is establishing importance in the world's food chain as a functional food. Edible flaxseed products include the whole flaxseed, ground meal and extracted oil or mucilage. These products have been proposed as a nutritional additive in the preparation of a number of dietary items such as baked cereal products, ready to eat cereals, fiber bars, salad toppings, meat extenders, bread, muffins and sphagetti (Singh *et al*., 2011 [22]; Singh *et al*., 2011 b[23]). Flaxseed supplemented food products are gaining popularity because of its contents high polyunsaturated fatty acids, protein, soluble fiber and phytochemicals. Flax is rich in fat, protein and dietary fibre. The composition of flax can vary with genetics, growing environment, seed processing. Flaxseed lignans are metabolize to mammalian lignans, primarily enterolactone (EL) and enterodiol (ED), by colonic microbiota (Duncan *et al*., 2003) [6], which exert biological activities such as anticancer (Danbara *et al*., 2005) [5]; Qu *et al*., 2005 [18], antioxidative, antiestrogenic, and anti-inflammatory activities (Kuijsten *et al*., 2005) [14]; Jin *et al*., 2012 [12].

Materials and Method

Plan of Work

The experimental work "Studies on carrot and apple blended jam fortified with flaxseed" was carried out in the lab of Food Technology-I, Warner College of Dairy Technology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj.

Procurement of ingredients

Carrot was collected from the local market of Prayagraj. Apple was collected from the local market of Prayagraj. Flaxseed was collected from the local market of Prayagraj. Sugar was procured from the local market of Prayagraj. Citric acid was collected from the lab of food Technology-I in Warner College of Dairy Technology.

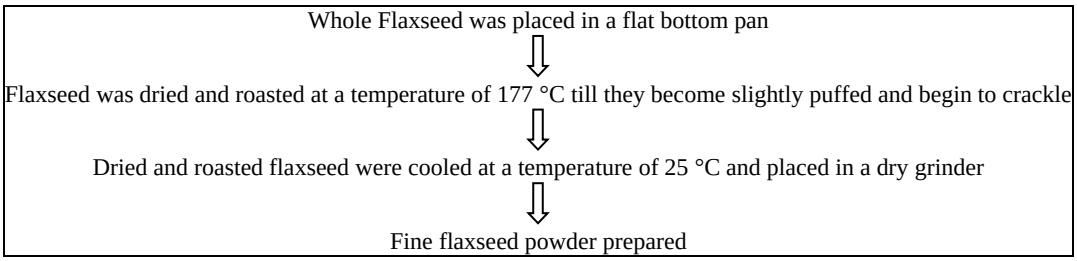

Fig 1: Flowchart for grounded flaxseed preparation

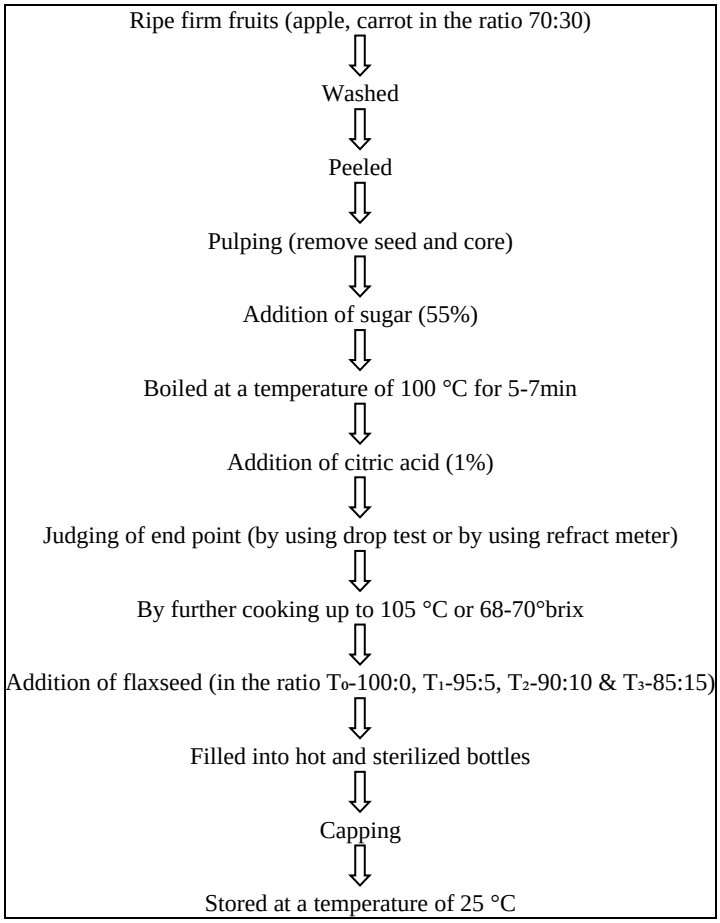

Fig 2: Flow chart for processing of Jam

Treatments combination of control and experimental:
To- was prepared by using apple (A) + carrot(C) and flaxseed (F) in ratio (100:0)
T_1- was prepared by using apple (A) + carrot(C) and flaxseed (F) in ratio (95:5)
T_2- was prepared by using apple (A) + carrot(C) and flaxseed (F) in ratio (90:10)
T_3- was prepared by using apple (A) + carrot(C) and flaxseed (F) in ratio (85:15)

Chemical Examination of Prepared Jam
The samples of finished product from various treatment combinations were chemically analyzed for Ascorbic acid(FAO 14/8, manual food quality control), Acidity (AOAC 17th edn official method 942.5, 2000), TSS (by hand refractometer, method 138.15, 1993), pH(AOAC method 981.12), Ash (Manual of analysis of fruits and vegetable product by S.Rangana (1977), Moisture(ISI handbook of analysis, 984, 2000), Total sugar (lane & Eyenon method), Total antioxidant activity(FRAP method).

Microbiological Analysis of Prepared Jam
Microbiological parameters were determined by using standard procedure for Yeast and mould count (APHA standard method for food product 1992) by using Potato glucose agar medium and Coliform count (ISO standard 2000) by using Meconkey's broth medium.

Sensory Evaluation
Sensory evaluation of prepared Jam was carried out by a panel of judges comprising "9 point Hedonic scale.

Statistical Analysis
The results obtained were analyzed statistically by using Randomized Block Design (RBD) with analysis of variance at 5% level of significance.

Results and Discussion
The present study was based to evolve "Studies on carrot and apple blended jam fortified with flaxseed". The data collected on different aspects were tabulated and analyzed statistically using the method of analysis of variance and critical difference. The significant and non-significant differences observed have been analyzed critically within and between the treatment combinations of chemical characteristics of blended jam, Microbiological characteristics of blended jam and Sensory characteristics of blended jam

Table 1: Mean value of Chemical analysis of different parameters of carrot and apple blended jam fortified with flaxseed

Parameters	Treatments				
	To	T_1	T_2	T_3	C.D. at 5%
Chemical Analysis (in percent)					
Ash%	0.62±0.01	0.63±0.01	0.65±0.01	0.65±0.01	0.01
TSS(°brix)	69.58±0.49	69.46±0.44	68.80±0.53	68.64±0.54	0.51
Moisture%	30.42±0.50	30.54±0.44	31.20±0.53	31.36±0.47	0.51
Acidity %	0.35±0.01	0.33±0.00	0.32±0.05	0.31±0.01	0.01
pH	3.19±0.04	3.25±0.05	3.26±0.06	3.27±0.05	0.07
Total sugar%	62.85±0.65	64.12±0.19	64.34±0.19	64.40±0.33	0.53
Ascorbic acid(mg)	15.74±0.46	13.79±0.39	12.50±0.89	11.82±0.21	0.53
%Total antioxidant activity	0.70±0.01	0.87±0.01	0.96±0.00	0.97±0.01	0.06

Chemical characteristics
Ash percentage
Ash percentage of different treatments and control, the highest mean ash percentage was recorded in the jam sample of T_3 (0.65) followed by T_2 (0.65), T_1 (0.63) and T_0 (0.62). An addition of flaxseed (5, 10 and 15 per cent) significantly increases in ash (63.00, 65.00 and 65.00) in finished product as compare to control (0.62). It indicates significant difference between the treatment (P<0.05). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean value of T_0-T_1 (0.01), T_0-T_2 (0.03), T_0-T_3 (0.03), T_1-T_2 (0.02) and T_1-T_3 (0.02) was less than the C.D. value (0.01). Therefore, the difference was significant and the difference between the mean values of T_2-T_3 (0.00) was less than the C.D. value (0.01), the difference was non-significant.

Total Soluble Solids (°Brix)
The TSS (°Brix) in jam samples of different treatments and control, the highest mean was recorded in sample T_0 (69.58) followed by T_1 (69.46), T_2(68.80) and T_3(68.64). The observed values represented that different treatments significantly influence TSS of the carrot, apple and flaxseed blended jam samples and the difference was significant (P<0.05). Ehsan *et al*., (2003) [7]. Also observed an increase in TSS from 66.5 to 68.8°Brix in fruit jam. Ehsan *et al.,* (2003) [7]; Hussain and Shakir (2010) [10]. Also found an increase in TSS from 70°Brix to 70.8°Brix in watermelon and lemon jam and the increase in TSS might be due to hydrolysis of starch into simple sugar.

Moisture Percentage
The moisture percentage in jam samples of different treatments and control, the highest mean moisture percentage was recorded in the jam sample of T_3 (31.36) followed by T_2 (31.20) T_1 (30.54) and T_0 (30.42). The moisture content of the control was found to be lower than that of the jam and it slowly increased from T_1 to T_3, because of the higher moisture content in the flaxseed. The difference between the mean values of T_0-T_2 (0.78), T_0-T_3 (0.94), T_1-T_2 (0.66) and T_1-T_3 (0.82) was greater than the C.D. value (0.51). Therefore, the difference was significant (P<0.05). The difference between the mean value of T_0-T_1 (0.12) and T_2-T_3 (0.16) was less than the C.D. value (0.51). Therefore, the difference was non- significant.

Acidity percentage
Acidity percentage in jam samples was recorded highest in treatment T_0 (0.35) followed by T_1 (0.33), T_2(0.32) and T_3(0.31). The acidity percentage of the control was found to be higher than that of the prepared jam and it slowly decreased from T_1 to T_3. It shows significant difference between the treatment (P<0.05). Khan *et al*., (2012) [13] found

raise in acidity of fruit jam during storage period. This high acidity of fruit jam might be due to the hydrolysis of pectin and degradation of ascorbic acid. The increase in acidity of fruit jam in storage resulted due to sugar breakdown and increase in the total soluble solid of the samples (Riaz *et al*., 1999) [19].

pH

pH in jam samples of different treatments and control, the highest mean pH was recorded in treatment of T_3(3.27) followed by T_2(3.26),T_1(3.25) and T_0 (3.19). pH of the fruit sample is very important because it helps in the formation of optimum gel in the preparation of jam. In contrast, the pH value of apple and apricot jam studied by Anjum *et al*., (2000) [1] were found in jam.

Total sugar percentage

Total sugar percentage was recorded highest in treatment of T_3 (64.40) followed by T_2 (64.34), T_1 (64.12) and T_0 (62.85). The significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_1 (1.27), T_0- T_2 (1.55) and T_0-T_3 (1.49) was greater than C.D. value (0.53), the difference was significant. The difference between the mean values of T_1-T_2 (0.28), T_1-T_3 (0.22) and T_2-T_3 (0.06) was less than C.D. value (0.53), the difference was non-significant.

Ascorbic acid (mg/100)

The ascorbic acid percentage of different treatments and control, the highest mean ascorbic acid percentage was recorded in the jam sample of T_0(15.74) followed by T_1 (13.79), T_2 (12.50) and T_3 (11.82). The ascorbic acid content of the control was found to be higher than that of the prepared Jam and it decreased from T_1 to T_3, Therefore, this indicating significant effects of treatments on ascorbic acid in mg/100. The ascorbic acid content of strawberry jam significantly decreased from 18 mg/100 g to 13 mg/100 g (Singh *et al*., 1999) [24]. Similar trend was observed in decline ascorbic acid content of fruit jam by Veltman *et al*., (2000) [27]. The loss of ascorbic acid content is because of light in the storage environment of the product.

Total antioxidant activity percentage

Total antioxidant activity in jam samples of different treatments and control, the highest mean total antioxidant activity was recorded in treatment of T_3 (0.97) and lowest was found in sample T_0 (0.70). The significant difference was further analyzed statistically to find out the C.D. between and within different treatment combinations. The difference between mean values of T_0-T_1 (0.17), T_0-T_1 (0.26), T_0-T_2 (0.27), T_1-T_2 (0.15) and T_1-T_3 (0.1) was greater than the C.D. value (0.06). Therefore, the difference was significant. The difference between the mean values of T_2-T_3 (0.05) was less than the C.D. value (0.06) therefore, the difference was non-significant.

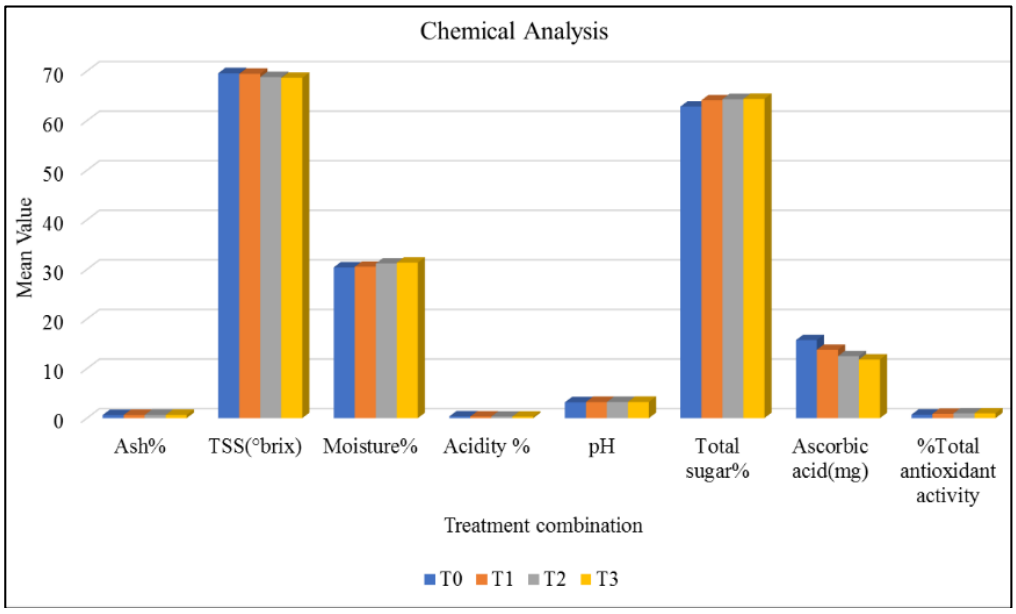

Fig 3: Graphical representation of Chemical Analysis of carrot and apple blended jam fortified with flaxseed

Microbiological characteristics

Table 2: Mean score of Microbiological characteristics of different parameters of carrot and apple blended jam fortified with flaxseed.

Parameters	Treatments				
	To	T_1	T_2	T_3	C.D. at 5%
Microbiological analysis					
Yeast & mold count(cfu/gm)	6.20±0.83	4.80±0.84	4.20±0.84	3.80±0.83	1.30
Coliform	Nil	Nil	Nil	Nil	

Yeast and Mould (cfu/g) count

The Yeast & Mould count (cfu/g) in jam samples of different treatments and control, the highest mean yeast & mould was recorded in the jam sample of T_0(6.20) followed by T_1(4.80),T_3(4.20) and T_2(3.80). The difference between the mean value of T_0-T_1 (1.40), T_0-T_2 (2.00) and T_0-T_3 (2.40) greater than the C.D. value (1.30). Therefore, the difference was significant. The difference between the mean values of T_1-T_2 (0.60), T_1-T_3 (0.10) and T_2-T_3 (0.40) less than the C.D. value (1.30). Therefore, the difference was non-significant.

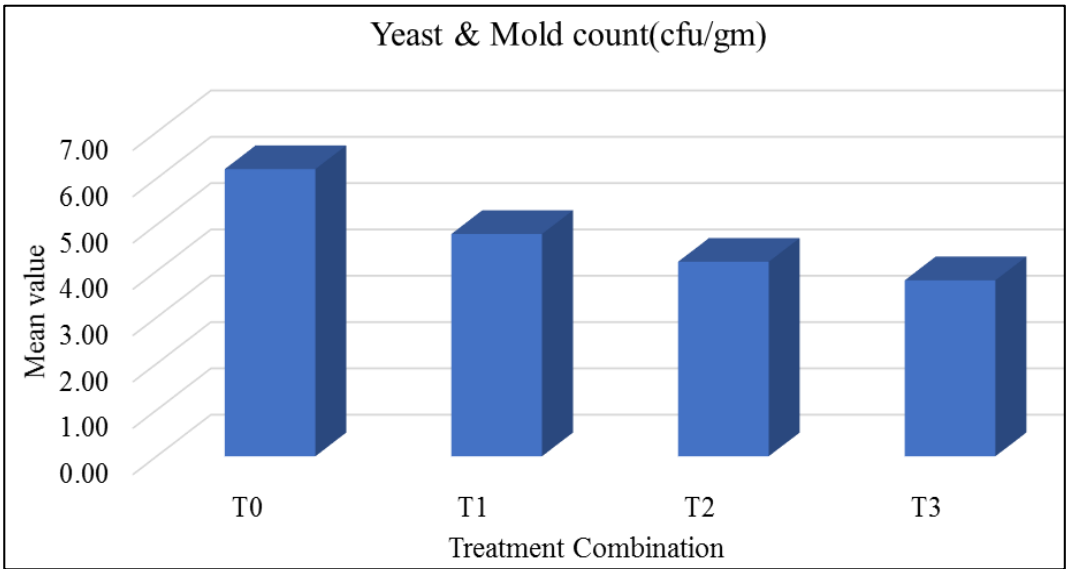

Fig 4: Graphical representation of Yeast and Mould (cfu/g) count of carrot and apple blended jam fortified with flaxseed

Coliform test

The result of coliform test count of control and experimental samples of jam is negative. It shows gram –ve (gram negative bacteria), which means that strict hygienic procedure was observed during it preparation.

Organoleptic evaluation

Table 3: Mean score of organoleptic evaluation of different parameters of carrot and apple blended jam fortified with flaxseed.

Parameters	Treatments				
	To	T_1	T_2	T_3	C.D. at 5%
Organoleptic scores (9 point hedonic scales)					
Color & appearance	7.68±0.27	7.79±0.28	8.00±0.23	7.66±0.24	0.39
Body & texture	7.50±0.50	7.48±0.30	7.98±0.34	7.42±0.21	0.46
Flavor & taste	7.90±0.17	7.94±0.35	8.38±0.44	7.70±0.15	0.33
Overall acceptability	7.74±0.14	7.72±0.09	8.00±0.14	7.64±0.54	0.20

Color and appearance score

The sensory score for colour and appearance of the samples from T_0 to T_3 were found in the range of 7.66 to 8.00, which increased substantially throughout the sample T_0 to T_3. Color & appearance score in jam samples of different treatments and control the highest mean was recorded in treatment of T_2 (8.00) followed by T_1 (7.79), T_0 (7.68) and T_3 (7.66). The difference between the mean value of T_0-T_1 (0.11), T_0-T_2 (0.32), T_0-T_3 (0.02), T_1-T_2 (0.21), T_1-T_3 (0.13) and T_2-T_3 (0.34) less than the C.D. value (0.39). Therefore, the difference was non-significant (P>0.05).

Body and texture score

The panelist scores for body and texture of carrot and apple blended jam from T0 to T3 were found in the range of 7.42 to 7.98. The highest body & texture mean score recorded in the blended jam sample of T_2 (7.98) followed by T_0 (7.50), T_1 (7.48) and T_3 (7.42). The non-significant difference was further analyzed statistically to find out the C.D. between and within the different treatment combinations. The difference between the mean values of T_0-T_2 (0.48), T_1-T_2 (0.50) and T_2-T_3 (0.56) greater than the C.D. value (0.46). Therefore, the difference was significant and the difference between the mean value of T_0-T_1 (0.02), T_0-T_3 (0.08) and T_1-T_3 (0.06) less than the C.D. value (0.46). Therefore, the difference was non-significant.

Flavor and taste score

The sensory score for flavour and taste of apple, carrot and flaxseed blended jam were in range of 7.70 to 8.38, which gradually obtained a lower score from treatment T_0 to T_1 and T_0 to T_3. Flavor and texture score in jam samples of different treatments and control, the highest mean score was recorded in the jam sample of T_2 (8.38) followed by T_1(7.94), T_0(7.90) and T_3(7.70).

Overall acceptability score

Overall acceptability score in jam samples of different treatments and control the highest mean overall score was recorded in treatment of T_2(8.00) followed by T_0(7.74), T_1(7.72) and T_3 (7.64). The difference between the mean values of T_0-T_2 (0.25), T_1-T_2 (0.27) and T_2-T_3 (0.36) greater than the C.D. value (0.20), the difference was significant and the difference between the mean value of T_0-T_1 (-0.12), T_0-T_3 (0.11) and T_1-T_3 (0.08) less than the C.D. value (0.20). Therefore, the difference was non-significant.

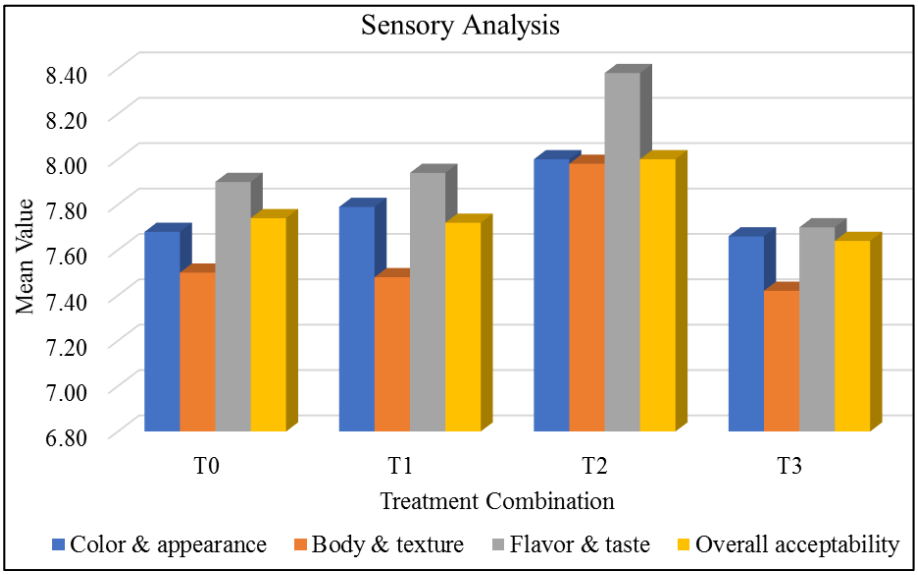

Fig 5: Graphical representation of Sensory Analysis of carrot and apple blended jam fortified with flaxseed

Conclusion

The highest mean value for ash, moisture, pH, Total sugar and antioxidant activity percentage of jam was recorded in treatment T_3 and lowest mean value was recorded in treatment T_0 and similarly, the lowest mean value for TSS, acidity and ascorbic acid of jam was recorded in treatment T_0 and lowest mean value was recorded in treatment T_3. The highest mean value for yeast and mould (cfu/gm) counts of jam for controlled and treatment was recorded in T_0 and coliform test was found negative in all the treatment. The study sought to find out the organoleptic acceptance of the prepared blended jam fortified with flaxseed with different treatments in terms of body and texture, color and appearance, flavor and taste and overall acceptability. However, T_2 (90:10) was the most liked prepared jam treatment with highest score for nearly all the evaluating parameters. With the addition of flaxseed, the antioxidant activity was increased in jam and the best and most accepted form of jam was T_2.

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