Effect of heat transfer on the rheological and mechanical properties of some selected foods

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Tomato are considered as one of the most popular fruits for a large sector of consumers overall the world, even their incomes are different. Tomato is a fleshy beery, shaped like a globe, or depressed at both ends. When young, it is hairy but becomes smooth and turns red or yellow when ripe. The color is due to pigments: lycopene and carotenoids. Lycopene is responsible for the red color. Tomatoes are smooth or ridged and about 2 to 15 cm in diameter. They contain numerous seeds which are haird and light brown. There are different types of tomato. The fruits are usually graded for size and quality. Fruits about 8 cm indiameter are preferred.Ripe tomatoes contain about 94 % water, as well as source of vitamin Aand some vitamin C. The fruit are eaten raw or cooked in soups and stews. They are canned, juiced and made into sauces, ketchup, puree, paste and powder.The current investigation was carried out to evaluate the effect of heat treatment and heat temperature on chemical, sensory, physical, mechanical and rheological properties of (tomato, cherry and apricot) fruits and their products. Effect of storage temperature and storage time on the chemical, physical, mechanical and rheological properties of (tomato, cherry and apricot) fruits and their products.The current study was subjected to the following points during theinvestigation:1.Evaluation the chemical composition, rheological behavior and sensorycharacteristics of some Egyptian and German tomato ketchups.2.Determination of rheological parameters for some tomato ketchups andtomato products.3.Comparison between rotational rheological measurements and oscillatoryrheological measurements.4.Effect of the storage at different (temperatures and periods) on rheologicalbehavior of some Egyptian and German tomato ketchups.5.To evaluate the chemical composition and their effects on rheological behavior of tomato ketchup, tomato juice, tomato puree, tomato paste, cherrynectar, cherry puree and apricot puree.6.The effect of temperature on rheological behavior of tomato ketchup, tomatojuice, tomato puree, tomato paste, cherry nectar, cherry puree and apricotpuree.7.To determine the activation energy of tomato ketchup, tomato juice, tomatopuree, tomato paste, cherry nectar, cherry puree and apricot puree.8.To determine the mechanical characteristics of tomato, cherry and apricotfruits.9.Evaluation the change in mechanical characteristics of tomato, cherry andapricot fruits during the storage at different temperatures.10.To study the effect of ripening changes in tomato fruits on those properties obtained by mechanical tests.Summary16511.Study the effect of heat treatments on rheological and mechanical characteristics of tomato, cherry and apricot fruits.12.Comparison between cherry products for their chemical composition, rheological properties and sensory characteristics.13.To estimate of squeezing, pumping, evaporation, filling, mixing, storage behavior of fruits and derivated products.14.Investigation of texture and flow behavior of import fruits science (process viscosities)The obtained data could be summarized as follows:1.Chemical composition and physical properties of some Egyptian and German tomato ketchups and effect of storage:Moisture content, total solids, pH, titratable acidity, total sugars, reducing sugars, non-reducing sugars, total pectic substances, water soluble pectin, acid soluble pectin, ammonium oxalate soluble pectin, colour index, ascorbic acid were determined in the tomato ketchups samples of investigation. Total solids, pH and total pectic substances values were higher in the controls, also decreased with increasing storage temperature (5, 20 and 30 °C). where titratable acidity was lower in the controls, titratable acidity increased in stored samples with increasing storage temperature.2.Chemical composition of tomato juice, puree and paste:a good correlation was found between total solids (TS) and (ash, titratable acidity, pH values, ascorbic acid, starch, total sugars, total pectic substances, pulp content, specific heat capacity and density), for tomatoes products.3.Rheological behavior of tomato ketchups:Rheological properties of tomato ketchups were studied at a whole range of temperatures at 0, 10, 20, 30, 40 and 50 °C. Tomato ketchup showed non-Newtonian fluids characters. It showed pseudoplastic behavior at all assayed temperatures with thixotropy or rheopectic by applying the different mathematical models. In ”Pseudoplastic materials” the apparent viscosity decreases as the rate of shear at which the material was tested increased. This pseudoplastic behavior is the result of a complex interaction among the pulp, soluble pectin, organic acids and soluble solids. The ”To” decreased when the temperature increased for the different tomato ketchups brands under investigation. The (K) consistency index (Pa.sn) increased with increasing the total solids, and decreased with increasing temperature. K and n decreased as temperature rose. The coefficient of correlation r for HB model ranged from 0.994 to 0.999 for all tomato ketchups samples. The yield values for CA model were higher than those obtained by HB model for all tomato ketchups and the correlation coefficient for Casson model was lower than that obtained using HBSummary166model for the different tomato ketchups brands under investigation. The leff CA values were higher than rleffHB values for all tomato ketchups brands.4.Oscillatory rheological measurements:All the ketchups samples showed G’> G”” in the LVE range, which means that they all have solid character at very low deformation during Oscillation tests. The tan 8 ranged between 0.27 to 0.18, 0.29 to 0.17, 0.24 to 0.19, 0.25 to 0.16, 0.21 to 0.17, 0.3 to 0.2, 0.23 to 0.16 and 0.27 to 0.19 for Lidl, Kraft, Werder, Heinz, Reichelt, Americana, Heinz Egypt and GSF Egypt tomato ketchups, respectively. Significant correlation was found between (tan 8) and temperature. The tan 8 decreased with increase in temperature.5.Influence of temperature on the rheological behavior of tomato ketchups:The effect of different temperatures in the range (0 - 50°C) on the apparent viscosity at shear rate equivalent to 100 s-1 for tomato ketchups were studied and the obtained data were used for Arrhenius plotting with square correlation coefficient (R2). The flow activation energy calculated from Arrhenius equation were ranged from 7.12 to 10.87 ki/mol.6.Effect of storage temperature and storage time on the rheologicalparameters of the tomato ketchups:Tomato ketchups samples affected by storage time and storage temperature. All samples showed a decrease in apparent viscosity as shear rate increased (shear thinning), a characteristic of pseudoplastic behavior. The storage duration and temperature showed higher significant effect on effective viscosity (left-FIB and rieffcA) for tomato ketchups. During storage for 6-month at 5, 20 and 30 °C there was a DROP in the (riefTHB and rieficA) of all tomato ketchups. After 6-month storage at 5°C, 20 °C and 30 °C Herschel-Bulkley model and Casson model parameters were significantly affected by storage temperature and storage time. It is concluded that the rheological model obtained can be used to predict changes that may take place in tomato products during storage.7.Effect of storage temperature and storage time on the flow activation energy of the tomato ketchups:The flow activation energy decreased with increasing the storage temperature for all tomato ketchups. A highest decreased in (Ea) was observed in all tomato ketchups samples stored at temperature 30 °C, followed by tomato ketchups samples stored at 20 °C. Storing of tomato ketchups for 6-month at 30 °C resulted in greater decrease in the Ea.8.Rheological behavior of tomato juice, tomato puree and tomato paste:Summary167The values for flow behavior index n were always lower than 1 which indicated the pseudoplastic nature of all tomato products evaluated. All tomato products the storage modulus G’ , was always higher than the loss modulus G—, there for the tomato products will behave more like a solid; that is, the deformations will be essentially elastic or recoverable. Which showed that the tomato products were more elastic than viscous. On the other hand it was noted that G’ and G” values had strongly depend on the total solids, G’ and G” were increased with an increase in total solids.7.Mechanical characteristics of tomato fruits and ripening changes in tomato fruits affected those properties obtained by mechanical tests:Texture is an important quality attribute for tomatoes fruits, texture may be the final index by which the consumers decide to purchase a given batch of tomatoes. If the elastic modulus values of tomatoes fruits are above 0.145 MPa they are suitable for making salad and even for marketing. In this red and ripe stage tomatoes were very fresh and firm, easily marketable. If elastic modulus values is above 0.212 MPa those tomatoes are definitely very firm and easily marketable in the supermarket. When the elastic modulus values of tomatoes reached to 0.071 MPa , the tomatoes were overripe. The tomatoes in this stage were very soft and could be used for just cooking or producing of tomato paste, and have very poor market quality.8.Chemical composition, physical properties and sensory characteristics of some cherry products:Total solids in cherry puree is higher than for the cherry nectars so that the cherry puree content is higher content of total sugars (11.17 %), total pectic substances (2.31 %), ascorbic acid (19.89 mg/100 ml), titratable acidity (1.52 %) and density (1078.09 kg/m3). The cherry puree has obtained the higher scores for the overall acceptability and other sensory attributes. In the same time the cherry nectar Lindavia have obtained the lower scores for the overall acceptability and other sensory attributes.9.Rheological behavior of cherry products:The flow index values n for the cherry nectar were nearly one indicating that the rheological behavior was non-Newtonian fluid and the degree of structure formation (n = 1 structure less Newtonian fluid). On the other hand the flow index values for cherry puree(n ranged between 0.49 and 0.60. These results indicated that cherry puree behaved as pseudoplastic fluid. By using the Ostwald model in all cases the correlation coefficients was higher than (r > 0.91) and showing increased pseudoplasticity for cherry puree (0.20 < n < 0.25), when all cherry nectars samples the values of (n) ranged between (0.43 to 0.71).Summary16810. Effect of storage temperature and variety of cherry on mechanical characteristics of cherry fruits:The maximum compression force and all mechanical parameters decreased with increasing time of storage for all cherry varieties under assay. The maximum compression force varied from 26.97 N (Spanish sweet cherry) to 16.94 N (Werder German sweet cherry). The Young’s modulus ranged from 0.0315 MPa (Spanish sweet cherry) to 0.0197 MPa (Werder German sweet cherry). The best storage conditions of cherries to keep fruit fresher were temperature around 4 °C and high relative humidity (90-95 %). All tested cherry had a good fruit weight and size.11.Chemical composition and physical properties of apricot puree:Some chemical and physical properties were made for apricot puree. The results for apricot puree showed moisture 83.06 %, total sugars 7.58 %, starch 0.46 %, total pectic substances 3.84 %, specific h1081.09 kg/m38,respectig ely.eat capacity 1.33 kJ/k K anddensity at temperatures 5 and 30 °C 1089.86 and v12.Rheological behavior of apricot puree:The dynamic moduli G’, 0- and tan 5 as a function of frequency (f) were determined for the apricot puree. Apricot puree is clearly viscoelastic. The dynamic parameters including tan 5 were increase with increasing f . The dynamic rheological data of In (G’, G”) versus In frequency for apricot puree at different temperatures (0 -50 °C) were also subjected to linear regression Apricot puree displayed a more solid like behavior and the magnitudes of K2 were much higher than those of K1 with a high dependence on frequency. The magnitudes of K1 and K2 also decreased with increase in temperature.13.Effect of storage temperature and storage time on mechanical characteristics of apricot fruits:In penetration test throughout storage the mechanical parameters values decreased for fruits under all conditions. Apricot stored under chilled conditions showed higher in maximum force, Young’s modulus, energy and energy]. While the deformation was the same in all conditions and all storage days.In compression test all mechanical parameters values decreased throughout storage time for apricot fruits under all conditions. These parameters for apricot fruit stored at nonchilled conditions were ranged from 25.23 to 5.71N ; 0.0233 to 0.0068 MPa ; 0.3062 to 0.0471 J ; 0.2494 to 0.0462 J and 13.01 to 10.61 mm for maximum force, Young’s modulus, energy, energy 1 and deformation, respectively. In the same time these parameters were ranged from 25.23 to 5.02 N ; 0.0233 to 0.0049 MPa ; 0.3062 to 0.0348 J ; 0.2494 to 0.0319 J and 13.01 to 9.66mm, for apricot fruit stored at chilled conditions.