SUMMARY

Part I: Preparation and characterization of fresh bananas and their dehydrated products:

This part of study covers a comparative investigation on the suitability of the main banana cultivars grown in Egypt, i.e. Maghrabi, Paradica and Sindihi for processing into dehydrated products such as banana slices (or rings) and banana powder as well as the establishment of optimum conditions for dehydrating these different cultivars. The obtained dehydrated products,from the three banana cultivars, were comparatively compared organoleptically, physically and chemically after dehydration and also after their subsequent storage in different containers for 6-9 months.

1. Selection of optimum predrying treatments:

The effect of various predrying treatments as well as temperature of dehydration on colour of dehydrated banana pulp slices prepared from three well-known cultivars grown in Egypt, were investigated. The predrying dipping solutions tested (citric acid, 0.5, 1.0, 2.0 % w/v, calcium chloride 0.1, 0.2, 0.3, 0.4, 0.5% w/v, sodium metabisulfite 1.0, 2.0 % w/v; and ascorbic acid 1.0% w/v) were compared for their efficiency in the control of enzymatic and non-enzymatic browning or colour change upon dehydration banana slices under two degrees of temperature (60°C or 80°C for the first 2 hours then finished at 60°C) for periods ranged from 6 to 18 hours.

1.Dipping in citric acid solutions (1 or 2% for 2 or 4 min) before drying failed to improve colour of all dehydrated

bananas. Moreover, soaking in 0.5% citric acid during peeling time (about 5 min) followed by dipping in any of the various solutions utilized did not improve colour scores.

2. Soaking Maghrabi and Paradica banana pulps in solutions of $Na_2S_2O_5$ (1, 2%), for 3 min before dehydrations resulted in dehydrated products of good colour scores upon drying at either 60°C or at 80°C treatment.

3. The substitution of ascorbic acid by $CaCl_2$ in solutions of 1% $Na_2S_2O_5$ certainly improved the colour of dehydrated bananas, regardless of dehydration temperature used.

4. Blanching in boiling water (with peel) for 3 min did not improve the colour of dehydrated pulp.

5. It was concluded that soaking in 1% $Na_2S_2O_5$ together with $CaCl_2$ (0.3 or 0.4 or 0.5%) produced an excellent and acceptable colour for bananas dehydrated at either 60°C or 80°C treatment.

6. With most of predrying treatments, Sindihi bananas showed dehydrated materials of better colour than those of Maghrabi and Paradica bananas. The successful dehydration of banana pulp slices was dependent on temperature of dehydration and concentration of various solutions in the predrying soaking treatment.

7. The period required for complete drying varied greatly with the type of banana cultivar and also with the temperature system applied.

8. Practical yield of dehydrated banana (weight of finished product/weight of pulp) indicated that maximum yield was obtained

with Sindihi and Paradica (34.96 and 34.72%, respectively) while the smallest yield was obtained with Maghrabi bananas (28.41%).

9. Bsides the superior colour scores after dehydration, processing of Sindihi was remarkedly more economic than the other two cultivars from the standpoint of energy consumption, moisture content and time required to reach complete dryness (about 4.3 to 4.6% moisture content).

10. Chemical predrying treatments had a negative influence on rehydration properties. However, dry Sindihi products had good rehydration properties.

11. Rehydration ratioes, coefficient of rehydration and moisture content(%)in rehydrated sample for dehydrated banana slices of Sindihi cultivar lied between 1:2.5 to 1:2.8, 0.87 to 0.98 and 61.64 to 65.93%, respectively, when determined at room temperature after soaking period of one hour.

2. Comparative chemical characterization of fresh starting bananas and their dehydrated products:

Fresh ripe pulps of Maghrabi, Paradica and Sindihi banana cultivars were analyzed chemically for their contents in moisture, crude protein, ether extract, ash, total carbohydrates, starch, total sugars, reducing and non-reducing sugars, pectic substances and distribution of their fractions, pigments, phenols, ascorbic acid, characteristic colour, mineral contents and enzymatic activities. In addition, dehydrated products from each cultivar were prepared using three different optimum predrying treatments which included the use of soaking solutions: treatment I (1% $Na_2S_2O_5$+0.3% $CaCl_2$), treatment II (1% $Na_2S_2O_5$ + 0.4% $CaCl_2$)

and treatment III (1% $Na_2S_2O_5$ + 1% ascorbic acid) for 3 min followed by dehydration at 80°C for the first 2 hrs then finished at 60°C until constant weight. The three dehydrated products prepared from ripe pulps of each banana cultivar tested beside a non treatment control were comparatively evaluated for their drying ratioes, organoleptic properties, rehydration characteristics, changes in their chemical constituents, as well as residual sulfur content, serum colour, degree of browning, enzymatic inhibition rate and also microbial load.

A. Ripe pulps of fresh bananas:

12. Fresh ripe pulps of the three banana cultivars showed some variation in their chemical composition. Carbohydrates constituted the major component in fresh pulps of the three banana cultivars. However, they did not differ greatly with type of cultivar where they ranged between (92.07-94.55%) on dry weight basis.

13. Maghrabi cultivar, in particular, exhibited the highest content in moisture, crude protein, ash, crude fibers, total sugars, non-reducing sugars, total pectic substances, NaOH-soluble pectin, pH, ascorbic acid, carotenoids total phenols and colour index but the lowest content in total carbohydrates ether extract, reducing sugars, starch, T.S.S., alcohol insoluble solids, acidity and serum colour.

14. Fresh pulp of Sindihi cultivar showed the highest content in ether extract, starch, ammonium oxalate-soluble

pectin, alcohol insoluble solids and serum colour, but the lowest content in crude protein, crude fiber, total sugars, total pectic substances, water soluble pectin, pH, carotenoids and total phenols.

15. Fresh pulp of Paradica cultivar had the highest content in total carbohydrates, reducing sugars, water soluble pectin, T.S.S. and acidity, but the lowest content in ash, non-reducing sugars, ammonium oxalate-soluble pectin, NaOH-soluble pectin,ascorbic acid and colour index .

16. Fresh pulps of Maghrabi had higher ascorbic acid than Paradica and Sindihi cultivars by about 148.4 and 96.9%, respectively. Paradica bananas had the lowest ascorbic acid content.

17. Fresh pulps of Maghrabi had higher carotenoids content (1.44 mg %) than Paradica and Sindihi cultivars by about 32.1 and 35.8%, respectively, and also higher total phenols content (206.44 mg %) by about 17.7 and 41.2%, respectively.

B) Dehydrated banana products:

18. Predrying and dehydration treatments as well as the drying temperature applied during preparation of different dehydrated banana slices and powders did not influence the chemical constituents originally present in their corresponding starting fresh bananas.

19. Moisture content in dehydrated banana products ranged between 4.26 to 6.99% where an average moisture content of 6.35, 6.19, and 4.99% was found in Maghrabi, Paradica and Sindihi groups, respectively.

20. On dry weight basis, there was no significant change in values for crude protein, ether extract, ash, total carbohydrate (by difference) total sugars, reducing, non reducing starch, crude fibers and total pectic substances contents between fresh ripe starting bananas and their corresponding dehydrated untreated controls regardless of the kind of banana cultivars.

21. No significant variation was found in contents for protein, ether extract, total carbohydrates , crude fibers and other carbohydrate constitutes between dehydrated treated products and their corresponding non treatment control bananas, regardless of the kind of banana cultivars. In contrast, with all banana cultivars, there was difference in moisture and ash contents between treated dehydrated samples and their corresponding non treatment controls where dry treated products had higher values than their controls.

22. As a result of dehydration a slight increase in acidity, total solids as well as oxalate and NaCH-soluble pectin fraction while a slight decrease in pH values, alcohol-insoluble solids and water-soluble pectin fraction was observed with all treatments of the three bananas.

23. Dehydration resulted in certain decrease in ascorbic acid , carotenoids and total phenols occurred with all treatments of the three bananas tested.

24. Maghrabi dry bananas showed the highest content in ascorbic acid, carotenoids and total phenols, while Paradica had the lowest content in ascorbic acid and also lower carotenoids content.

25. Compared to the initial level for ascorbic acid present in three starting fresh bananas, the average decrease in ascorbic acid was about 37.6% for all dehydrated three bananas tested, with the exception of treatment III which exhibited exceptional higher ascorbic acid content than other treatments tested.

26. An increase in colour index and a decrease in serum colour occurred as a result of dehydration of all treatments for three bananas.

27. Treatment II showed the lowest degree of browning and the highest values of serum colour with all banana cultivars.

28. All dehydrated Sindihi products showed the highest serum colour values, while dehydrated Paradica products had the lowest colour index (degree of browning).

29. Residual So_2 content varied greatly according to kind of banana cultivar and with predrying treatment, where it ranged between 216 to 228, 235 to 246 and between 257 to 265 ppm, respectively, for Maghrabi, Paradica and Sindihi bananas.

30. Although the three banana cultivars did not differ in the general gradual order of mineral distribution, they varied greatly with regard to concentration of each of these minerals. However, mineral matter in Maghrabi cultivar was almost higher than that present in Paradica and Sindihi cultivar.

31. From the standpoint of mineral availability, mineral elements in ripe pulp of the three banana cultivars were

ranked in a decreasing order of abundance, as K, Ca, Mg, Fe, P, Cu, Mn and Zn.

32. Potassium the principal element in ashes of ripe pulps of all dehydrated banana cultivars tested averaging 1064.516 mg/100 g dry weight.

33. Dehydrated banana powders contain appreciable amounts of minerals analysed and that could be used as a good source for these minerals in human foods. It seems that consumption as small as about 50 g of each of dehydrated banana products would satisfy the daily recommended allowance, and in turn requirements, for Mg (4-100 mg/day) while probably 200-250 g per day would be sufficient to provide requirements for Cu (1.3-2 mg/day), Ca (400-500 mg/day) for infants.

3. Storage stability of dehydrated banana products:

Experiments were conducted to study the effect of some factors which influence the shelf life of these prepared banana dry powders and dehydrated slices throughout their subsequent storage. Experiments included studying the effect of duration of storage at room temperature and the effect of type of packaging materials utilized through the storage on some physical and chemical attributes of the stored dehydrated banana products prepared from three principal banana cultivars grown in Egypt, i.e., Maghrabi, Paradica and Sindihi cultivars.

34. Moisture content increased gradually with the advancement of storage period at room temperature regardless of the

type of packages utilized during storage. However, this increase, in function of the duration of storage, was influenced by type of packaging material and also by previous predrying treatments as well as kind of banana cultivar.

35. Moisture content of Sindihi banana stored in aluminium foil bags and glass jars for 6 months ranged between 5.35 to 5.84 % and between 5.72 to 6.82%, respectively.

36. Maghrabi and Paradica dehydrated powder had moisture content in the range between 7.21 to 9.20% and 6.86 to 8.91% respectively, after 9 months of storage in polyethylene bags.

37. Rehydration properties of dehydrated Sindihi banana slices decreased gradually parallel to the advancement in storage period in function of previous pretreatment before dehydration and type of packaging material utilized during storage. The rate of decrease in rehydration ratioes, coefficient of rehydration and moisture content (%) in rehydrated sample of dehydrated Sindihi banana stored in aluminium foil bags ranged between 26.7 to 35.3%, 25.0 to 35.6% and between 16.0 to 21.9%, respectively, after 6 months.

38. Organoleptic scores of treated dehydrated Sindihi banana products were found better than those given for non-treated control samples after storage for 3 or 6 months. However, those prepared using treatment II exhibited the highest scores for colour, flavour and texture. Products stored in aluminium foil bags exhibited the higher scores for colour, flavour and texture than their corresponding stored in glass jars.

39. A very slight increase of a maximum of only 5% over acidity level (as malic acid) at zero time was noted after 6 months of storage of Sindihi and 9 months of storing Maghrabi and Paradica dry powders.

40. Dehydrated Sindihi powder showed a decrease in serum colour but an increase in colour index upon their storage at room temperature. The rate of decrease in serum colour or increase in degree of browning was greatly dependent on duration of storage but in function of type of packages and previous pretreatment before dehydration.

41. Regardless of the type of packages utilized, the decrease in serum colour and/or the increase in colour index, after 6 months of storage was more pronounced in the no treatment control than with the other treatments tested (sulfited samples).

42. The obtained results indicated that chemical predrying treatment had a positive influence on colour changes occurred during storage where pretreated powders exhibited lower browning degrees. Treatment II showed superior colour as indicated organoleptic tests.

43. The change in degree of browning or serum colour observed upon storing Maghrabi and Paradica dry powder for 9 months in polyethylene bags is not much higher than that observed with Sindihi dry powder stored for only 6 months in either aluminium foil bags or glass jars.

44. Starch and total sugars of dehydrated banana powders showed slight change in their concentration upon storage. Meanwhile, a measurable decrease in non-reducing sugars, and an

opposite increase in reducing sugars were observed in stored dehydrated bananas. The rate of such changes was dependent on duration of storage in function of type of packages, kind of cultivars, rather than previous pretreatment before dehydration.

45. The effect of storage was more pronounced on the pattern of distribution of the different pectin fractions rather than the concentration of total pectic substances.

46. The extent of decrease in total pectic substances as well as pattern of distribution of different pectin fractions varied greatly with the previous treatments before dehydration and also in function with type of packages.

47. Dehydrated Sindihi powder showed a tremendous decrease in sulphur dioxide content with the advancement of storage period at room temperature. The rate of such decrease was greatly dependent on duration of storage, rather than previous pretreatment before dehydration.

48. Residual sulphur content of dehydrated Sindihi powder prepared by either treatment tested and stored in two different packages ranged between 130 to 142 ppm after 3 months of storage and between 23.5 to 31.5 ppm after 6 months of storage. On the other hand, So_2 was completely lost after storing Maghrabi and Paradica dry powder for 9 months in polyethylene bags.

49. The rate of disappearance of So_2 was more pronounced with Sindihi bananas stored in glass jars than in aluminium foil bags, with slight higher So_2 retention for stored bananas of treatment I than treatment II.

50. Dehydrated banana powders showed a very slight decrease in total phenols with the advancement of storage at room temperature and type of packages did not significantly influence the phenolic content which ranged between 129.01 to 134.56 mg %,after 3 months and between 128.0 to 133.68 mg %, after 6 months of storing Sindihi products while after 9 months of storing they ranged between 150.45 to 170.50 mg% in Maghrabi and between 133.93 to 146.16 mg % in Paradica dry bananas.

51. Activity of polyphenoloxidase enzyme (PPO) in fresh banana pulp was tremendously reduced and varied greatly with the treatment applied due to temperature used and according to So_2 pretreatments applied before drying.

52. Although all dehydrated bananas stored for 9 months had lower PPO activity than the initial level found originally in fresh pulp , they had higher PPO activity levels than those levels present at zero time (before storage) with all treatments.

53. The increase in PPO activity in stored bananas over the levels at zero storage times and just before packaging ranged between 54.49 to 145.0% depending also on pretreatment applied during processing.

54. Residual PPO activity after dehydration ranged between 10.6 to 13.25% and was increased after subsequent storage to between 16.40 and 32.45% of the initial activity present in fresh fruit.

55. Total bacterial as well as mold and yeast counts of dehydrated Sindihi powder did not show any increase with the advancement of storage period. Previous pretreatment before dehydration and type of packages did not influence the microbial load of dry bananas.

Part II : Guavas:

Preparation and characterization of fresh guavas and their dehydrated products:

This part of study covers a comparative investigation on the suitability of the main guava cultivars grown in Egypt, i.e. white-fleshed "Baladi" guava for processing into dehydrated products such as guava slices and powder and also the establishement of optimum conditions for dehydrating pulps of this cultivar. The guava processed products were comparatively compared organoleptically, physically and chemically after their subsequent storage in different containes for 6 months.

1. Establishment of optimum conditions for dehydrating guava fruits:

The effect of various predrying treatments as well as temperature of dehydration on colour of dehydrated white fleshed "Baladi" guava cultivar grown in Egypt was investigated. The predrying dipping solutions tested included the the application of 1% citric acid solution during manual peeling period followed by dipping in sodium metabisulfite solutions (0.1, 0.2, 0.3, 0.4 and 0.5% w/v). These pre-treatments beside a non-treatment samples were compared for their efficiency in the control of enzymatic and non-enzymatic browning or colour changes upon dehydrating guava slices under three degrees of temperature (50°, 60°, 70°C)for periods ranged from 7 to 10 hours.

56. The successful dehydration of peeled guava slices was dependent on temperature of dehydration and the

concentration of $Na_2S_2O_5$ in the predrying soaking treatment.

57. Peeled sliced guava dehydrated at 60°C previously pretreated with any of the tested dipping solutions exhibited excellent colour scores which were higher than that given for their corresponding control sample (good score).

58. The increase in concentration of $Na_2S_2O_5$ more than 0.2% of the soaking solution improved colour score of dehydrated guava dried at 70°C.

59. Unpeeled guava slices did not show acceptable colour scores upon using citric acid dip and sodium metabisulfite soaking solutions (of various concentrations) before dehydration at temperatures of 50° or 60° or 70°C.

60. Two pretreatments produced the maximum colour scores for dehydrated products e.g., soaking in solutions of treatment I (0.2% $Na_2S_2O_5$) and treatment II (0.3% $Na_2S_2O_5$) for 3 min followed by dehydration at 60°C until constant weight (8 hrs).

61. Dehydration ratioes were found to differ according to percentage of moisture content before and after processing and also with predrying treatment applied before dehydration.

62. The different dehydrated guavas showed drying ratioes between 7.73:1 to 7.76:1 depending on pretreatment before drying.

63. Treated dehydrated guava slices and also powders were found to have better colour and texture scores than those for non-treated control samples.

64. Dehydrated guava slices or powder prepared using treatment II were found more acceptable since they exhibited

higher colour and texture scores than non-treated control and also treatment I.

65. The rehydration ratio, coefficient of rehydration and moisture content (%) in rehydrated samples showed variation in their values in function of previous treatment before dehydration.

66. Treatment II had the highest rehydration properties.

2. Comparative chemical characterization of fresh starting guavas and their dehydrated products:

The three dehydrated products (prepared using control, treatment I and II) prepared from ripe pulps of guava cultivar tested were comparatively characterized from the standpoint of their chemical constituents such as moisture content, crude protein, ether extract, ash, total carbohydrates, total reducing and non-reducing sugars, total pectic substances and distribution of their fractions, pigments, phenols, ascorbic acid, residual sulphur dioxide, serum colour, mineral contents and enzymatic activities and also their microbial load.

A) Ripe pulp of fresh Baladi guavas :

67. Fresh guava pulp contains 88.02% moisture, 4.16% crude protein, 1.54% ether extract, 3.09% ash and 91.21% total carbohydrates on dry weight basis.

68. Fresh guava pulp contained 41.38%, total sugars; 26.73%, reducing sugars; 14.65%,non-reducing sugars; 19.80%, crude fibers; 4.77%, total pectic substances; 2.44%, water-soluble pectin; 0.95%, ammonium oxalate-soluble pectin and 1.38% sodium hydroxide-soluble pectin on dry weight basis.

69. Fresh guava pulp contained 4.11% total acidity, pH value of 4.11, 1666.53 mg/100 g ascorbic acid, 1.20 mg % carotenoids and 540.26 mg% total phenols, on dry weight basis.

B) Dehydrated guava products:

70. No considerable changes were observed in crude protein ether extract, ash, total carbohydrates, crude fibers, total reducing and non-reducing sugars between fresh guava pulp and their dehydrated untreated control samples.

71. No considerable changes in proximate chemical composition and carbohydrate constituents were found between dehydrated untreated control and their corresponding dehydrated guavas of the two treatments.

72. Dehydrated treated samples showed lower moisture and higher ash contents than their corresponding dehydrated untreated controls.

73. Dehydration resulted in a measurable increase in total solids and very slight or trivial increase in alcohol insoluble solids with all guava treatments which did not exceed a maximum 0.24%.

74. After dehydration, the extent of increase in acidity did not exceed a maximum 1.22% higher than the initial acidity level in fruit before dehydration.

75. Different dehydrated guava treatments showed a narrow range of variation in ascorbic acid content (between 1049.9 to 1058.8 mg/100 g on dry weight basis), where certain decrease in ascorbic acid occurred as a result of dehydration,

with all treatments. The average decrease in ascorbic acid was about 37.0% lower than levels present in starting fresh Baladi guavas.

76. With all guava treatments, a measurable decrease in total phenols (by 8.96% on average) occurred after dehydration, but only very slight decrease in carotenoids was noted which not exceed a maximum 1.67% lower than that of fresh fruit level.

77. An increase in colour index while a decrease in serum colour occurred as a result of dehydration of all guava treatments. Compared to starting fresh guava, the rate of increase in degree of browning was 46.15 and 23.08% for no treatment control and treatment I, respectively, while treatment II did not show any significant increase. However, the degree of browning for treatment II was lower than those found for treatment I and no treatment control by about 25.0 and 36.84%, respectively.

78. Sulphur content of dehydrated guava powders prepared by treatment I and II was 78.3 and 120.15 ppm, respectively, after dehydration (at zero time). Treatment II showed higher residual So_2 than that in treatment I by about 53.4%.

79. Potasium was the principal element in ashes of dehydrated pulp and peels of guavas while calcium was the principal element in ash of dehydrated seeds. The second element in dehydrated pulp powder was Na,while in dehydrated peels and seeds was Ca and K, respectively.

80. Dehydrated pulp powder of guavas had the highest content in Na, Fe, while dehydrated peels exhibited the highest content in K but dehydrated seeds showed the highest content in Ca, Mg, P, Cu, Mn, Zn.

3. Storage stability of dehydrated guava powder:

Experiments were conducted to study the effect of some factors which influence the shelf life of the prepared guava dry powders and dehydrated slices throughout their subsequent storage. Experiments included studying the effect of duration of storage at room temperature and the effect of type of packaging materials utilized through the storage on some physical and chemical attributes of the stored dehydrated guava products prepared from white-fleshed "Baladi" guava cultivar grown in Egypt.

81. Dehydrated guava powder showed an increase in moisture content with the advancement of storage period which ranged between 7.78 to 13.35% after 6 months of storage. The average increase in moisture content of dehydrated guava powder stored in either polyethylene bags or glass jars over the level in the corresponding samples before storage (zero time) was in the rate of 6.19 and 5.77%, respectively, after 3 months and 12.66 and 12.10%, respectively, after 6 months of storage.

82. Dehydrated guavas packed in polyethylene films exhibited a very slight high moisture content than their corresponding samples packed in glass jar packages, especially after 6 months of storage.

83. Rehydration properties of guava slices improved gradually parallel to the increase in storage period of products kept at room temperature in either polyethylene bags or glass jars in function of previous pretreatment before dehydration and type of packaging material utilized during storage.

84. The rate of increase in rehydration ratioes, coefficient of rehydration and moisture content (%) in rehydrated sample of dehydrated guava slices stored in polyethylene bags varied greatly and ranged between 6.5 to 17.1%, 16.3 to 24.4% and between 6.03 to 7.8%, respectively, after 6 months of over the levels present in their corresponding dehydrated guava slices before storage.

85. Scores of treated stored dehydrated guava slices and powders were found better than those given for the stored non-treated control samples. Regardless of type of packages, dehydrated guava prepared using treatment II exhibited the highest score for colour, flavour and texture upon storage for 6 months.

86. Certain changes occurred in colour of stored guava powders at room temperature with the proceeding of storage period. A decrease in serum colour and increase in colour index data was observed with the advancement of storage. The rate of such change was greatly dependent on duration of storage but in function of type of packages and previous pretreatment before dehydration.

87. It was evident that storing guavas in glass jars packages induced a higher serum colour (better serum colour) and lower degree of browning values than their corresponding powders packed in polyethylene bags and such change in both values was more pronounced after 6 months than after 3 months of storage.

88. Dehydrated guava powders showed a very slight decrease in acidity and ascorbic acid content with the extension of storage period. The rate of such decrease was greatly dependent on the increase in duration of storage period, rather than the differences in type of packaging material utilized or in previous predrying treatments.

89. The average decrease in ascorbic acid content of all stored powders was of only 5.45%, after 3 months and of 12.74 after 6 months of storage compared to the levels present initially before storage. Therefore, the average retention in ascorbic acid content of dry guava powder was 94.55% and 87.26%, after 3 and 6 months of storage, respectively.

90. Total and non-reducing sugars of dehydrated guava powder decreased slightly while reducing sugars increased also slightly. However, the type of packages and previous pretreatment before dehydration did not significantly influence those concentrations.

91. The effect of storage was more pronounced upon the change in pattern of distribution of the different pectin fraction rather than the change in total pectins content. Therefore, with the extension of storage period, there was

certain decrease in total pectin substances and in turn of two of its constituent fractions, ammonium oxalate and NaOH-soluble fraction while water-soluble fraction was subsequently increased.

92. Dehydrated guava powders showed a tremendous decrease in sulphur dioxide content with the elapsement of storage period at room temperature. The rate of decrease in So_2 was greatly dependent on duration of storage. Previous sulfuring pretreatment before dehydration and type of packages exhibited certain influence on such rate of decrease.

93. Stored dehydrated guavas showed an average decrease in residual sulphur content of about 61.47%, after 3 months of storage and 95.93% after 6 months of storage. Although of such loss in So_2, there was no tremendous change in colour as indicated organoleptic test as well as data on serum colour and degree of browning.

94. The rate of disappearance of So_2 was more pronounced with guavas stored in polyethylene bags than in glass jars.

95. Total phenols of guava powder did not show any measurable change with the advancement of storage.

96. Activity of polyphenoloxidase decreased after dehydrating fresh guava pulp and decreased further after storage of dehydrated products for 9 months at room temperature.

97. The loss in PPO activity immediately after dehydration ranged between 23.0 to 30.1% in all treatment while after 9 months of storage it ranged between 60.6 to 64.4% lower than

the initial starting activity level in fresh pulp, and ranged between 49.9 to 49.1% lower than the activity present before storage.

98. Residual activity of PPO in dehydrated guava powder at zero time ranged between 69.9 to 77.0% then decreased after 9 months of storage at room temperature to be between 35.6 to 39.4% of the initial activity present in fresh fruit and between 50.9 to 51.1% of the activity present before storage.

99. Total bacterial as well as mold and yeast counts of dehydrated guava powder did not show any increase with the advancement of storage period, previous pretreatment before dehydration and type of packages did not influence the microbial load of dry guavas.

100. In general after storage of dehydrated fruits there was an increase in moisture content, colour index, reducing sugars, water soluble pectin while a decrease in serum colour, starch, total sugars, non reducing sugars, total pectic substances, ascorbic acids, ammonium oxalate-soluble pectin, NaOH-soluble pectin, So_2, total phenols. Although dehydrated guava products showed an increase in rehydration properties after their storage, dehydrated banana products showed a decrease in their rehydration properties after their storage. Furthermore, dehydrated guava products showed a decrease in acidity and polyphenoloxidase enzyme activity but, in contrast, dehydrated banana products showed certain increase in acidity and polyphenoloxidase enzyme activity after storage.

Part III: Evaluation of by-products of processing ripe banana and guava fruits:

This part of study included the characterization of the inedible or untilizable portion of banana and guava fruit left after their processing, especially into dehydrated products. By-products included peels of bananas and guavas as well as guava seeds. These by-products were dried or dehydrated and characterized from standpoint of yield, drying ratio proximate chemical analysis, carbohdrate constituents such as total, reducing and non reducing sugars, crude fibers, pectin and their fractions, pigment, phenolic compounds, ascorbic acid and mineral matter contents.

1. Characterization of dehydrated peels of bananas from different cultivars grown in Egypt:

This part of study covered data on peels of Maghrabi, paradica and Sindihi bananas, the main banana cultivars grown successfully in Egypt, and included results of the determination of amount of inedible part of fruit, yield and drying ratio of the different dehydrated peels, and also complete analysis of some important chemical constituents.

A) Determination of amount, yield and drying ratio of peels:

101. Bananas cultivars grown in Egypt presented distinct variation in fruit components. Amount of peels ranged between 28.37 to 38.94% of total fruit weight depending on variety or cultivar tested. The variety Paradica had the heaviest and highest amount of pulp constituting 71.63% of total weight and

the lowest proportion in peels (28.37%).

102. Maghrabi bananas ranked the second from the standpoint of proportion of pulp and also peels. Sindihi cultivar exbibited the highest amount of peels (38.94%) but the lowest amount of pulps (61.06%).

103. Yield of dehydrated peels of Maghrabi, Paradica and Sindihi bananas was 5.03, 6.02 and 5.51% of total fresh weights while drying ratio of peels was 1:6.19, 1:4.71 and 1:7.07, respectively.

B) Chemical composition of dehydrated peels:

Although moisture content of fresh peels varied with kind of banana cultivar , they did not differ greatly after their dehydration, where moisture ranged between 4.72 to 5.26%, with Paradica dry peels having the highest moisture content.

104. Carbohydrates constituted the major component in dried banana peels (from 67.09 to 79.66%), regardless of the cultivars kind. Ash was the second major component in Maghrabi and Sindihi peels while ether extract ranked the second in Paradica peels.

105. Regardless of cultivar kind, crude protein ranked as the fourth component where Paradica and Maghrabi peels had higher amount (8.03 and 6.90%, respectively)than Sindihi peels (4.92%), on dry weight basis.

106. On dry weight basis, the highest value for total pectic substances and non-reducing sugars was found in ripe Maghrabi

dry peels while the highest value in reducing sugars and total sugars was registered for Sindihi dry peels. The highest content in crude fiber was found in Paradica dry peels (9.2%). Virtually non-reducing sugars were completely absent in peels of Paradica and Sindihi.

107. Water-soluble pectin fraction exhibited comparable proportion of total pectins present in peels of Maghrabi Paradica and Sindihi. On average ammonium oxalate fraction constituted between 20.7 to 28.2% while NaOH-soluble pectin fraction formed between 30.6% to 39.9% of total pectic substances presented in the three peels investigated.

108. Maghrabi peels had higher total chlorophylls by about 59.5% and 187.8% more than those present in Paradica and Sindihi peels, respectively.

109. Maghrabi peels contained higher carotenoids in amount of about 95% higher than those present in peels of both other cultivars, respectively.

110. The highest contents in chlorophyll A, chlorophyll B, total chlorophylls, total carotenoids were present in dry peels of Maghrabi cultivar.

111. Chlorophyll B in ripe peels of Maghrabi, Paradica Sindihi bananas were higher than those for chlorophyll A by 85.24, 65.44 and 49.5%, respectively.

112. Total phenols present in peels of ripe bananas ranged between 247.6 to 452.0 mg/100 g dry basis. Dried Maghrabi peels had the highest total phenols concentration while dried peels of Paradica had the lowest content.

113. Potassium was the principal element in ashes of dried peels of all banana cultivars under investigation, while calcium ranked the second in such respect. In general, mineral matter in dried peels of Maghrabi and Paradica cultivars were almost higher than those in dried peels of Sindihi cultivar.

114. Dried peels of three banana cultivars showed a great variation in amounts of each individual elements, especially K, Cu and Fe.

115. Maghrabi dry peels contained distinguished high Ca, K, Na and Cu as well as low Fe compared to peels of other cultivars.

116. Paradica dry peels showed the highest content in Fe, Mn and Zn and lowest content in Cu compared to peels of other cultivars.

117. Dried peels of Sindihi cultivar showed the highest content in Mg and lowest content in Zn, Mn, P, Na and Ca compared to peels of other cultivars.

2) Characterization of dehydrated peels of white-fleshed "Baladi" guava fruits grown in Egypt.

This part included data on amount yield and drying ratio of dehydrated peels resulted as by-products of processing white-fleshed Baladi guava grown commonly in Egypt. Moreover, results of complete chemical analysis including proximate

chemical composition, total sugars, reducing and non-reducing sugars, pectic substances as their fractions, chlorophylls, carotenoids, phenols, ascorbic acid and mineral matter content are provided.

118. Total residues left after processing of ripe guavas (peels + cores) constituted 37.17% of total fruit weight. Cores constituted 23.68% of total fresh weight, however, after removal of seeds they formed only 20.04% of total fresh weight. Peels and seeds represented a proportion of 13.48 and 3.65%, respectively, of fresh weight.

119. Dehydrated guava peels had a yield of only 1.81% of the total fresh weight with a drying ratio of 1:7.44, Yield of sun-dried guava seeds was 2.64% of total weight with a drying ratio of 1:1.38.

120. Proximate chemical composition of guava peels differed greatly than that of seeds of the same fruit. Carbohydrates constituted the major component in peels (91.97%) and also in seeds (82.04%) of the same guava fruit. Higher amounts of crude fiber were present in guava by-products where seeds contained higher levels (64.69%) than those in peels (15.67%).

121. Mineral matter was more concentrated in peels rather than in seeds where dehydrated peels exhibited the highest ash content (3.66%) than seed (0.99%).

122. Ash was the second principal component in dry peels while ether extract formed the second component in seeds(9.75%). Crude protein ranked the third, however, seeds contained higher amounts of protein (7.22%) than peels (2.53%).

123. Dehydrated peels had higher content in total carbohydrates and ash, but lower content in crude protein; ether extract and crude fiber than seeds, while sun dried seeds of guava fruits showed higher content in ether extract, crude protein and crude fiber, but lower content in ash and total carbohydrates than peels of the same fruit.

124. Reducing sugar constituted higher proportion of carbohydrates (32.92%) of guava peels. Pectin content was also high (5.12%) where water-soluble pectin formed 48.5% of total pectin, while ammonium oxalate-soluble and NaOH soluble-fractions constituted 19.1 and 32.4%, respectively).

125. Total chlorophyll content in dehydrated ripe guava peels reached 1.59 mg/100 g where about 50% of that value was chlorophyll A and the rest was chlorophyll B.

126. Contents in chlorophylls for ripe guava peels are higher than those present in Sindihi bananas peels but lower than those present in Maghrabi and Paradica peels.

127. Guava peels contained lower carotenoids (5.033 mg/100 g) than those present in peels of the three bananas tested (7.105 - 13.989 mg %).

128. Total phenolic compounds in peels of white-fleshed Baladi guavas were 1577.9 mg/100 g on dry weight basis, which is much higher (by about 192.06 %) than that reported in flesh of fresh pulp of the same fruit (540.3 mg/100 g) However, upon dehydration of peels, total phenols content decreased by about 62.40%.

129. Ascorbic acid content of white-fleshed Baladi guava peels was 3796 mg/100 g, on dry weight basis, which is much higher (by about 127.8%) than that found in flesh or fresh pulp of the same fruit (1666.53 mg %).

130. Upon dehydration of peels, ascorbic acid content decreased by about 77.0%, however, ascorbic acid content in dried peels is about half that present naturally in fresh pulp of the same fruit.

131. Despite of observed decrease in ascorbic acid level in dehydrated peels, ascorbic acid remained after dehydration is much higher than those concentration of vitamin C present in various fruits products.

132. Although fresh peels had higher ascorbic acid content than fresh pulp, dehydrated peels showed lower content (by 17 .0%) than that present in dehydrated pulps of the same fruit.

133. Potassium the principal element in ashes of dehydrated ripe peels, while calcium was the first major element in ash of sun-dried seeds. The second major element in dehydrated peels was Ca, while in dried seeds was K.

134. Dried peels and seeds showed a great variation in amounts of each individual elements, especially K, Na, and Mn. Dehydrated peels contained distinguished higher concentration of K, Na, and Fe and lower Ca, Mg, P, Cu, Mn and Zn than those present in dried seeds. Dried seeds exhibited the highest amounts in Ca, Mg, P, Cu, Mn and Zn, but the lowest in K, Na, and Fe compared to dried peels.

Part IV: Characterization of fresh and their corresponding dehydrated fruits using gas liquid chromatographic technique:

135. GLC chromatograms of sugars indicated the separation of 14 components from ripe fresh pulp of Sindihi banana as well as its dehydrated product. Rhamnose was the second major sugar (27.94%) followed by glucose (19.33%) then sucrose (3.56%) while cellobiose and arabinose formed minor proportions(1.89 and 0.79% of total sugars, respectively).

136. Quantitative estimation of sugars separated from dehydrated bananas revealed that 7 compounds (77.2% of total) were identified while another 7 compounds were not identified (22.8% of total). The major sugar was mannose (23.10%) followed by fructose (21.49%), unknown (20.70%), sucrose (18.61%) galactose (9.59%) and rhamnose (1.71%).

137. GLC analysis of sugar revealed the separation of 16 components from ripe fresh while-fleshed "Baladi" guavas but only 13 from its corresponding dehydrated product were present in the obtained chromatograms of which 6 components were identified (93.56%). The major components was sucrose (36.62%) followed by galactose (31.67%), fructose (11.50%), glucose (9.79%), unknown (3.04%), rhamnose (2.80%) then cellobiose (1.18%).

138. Upon dehydration of ripe fresh "Baladi" guavas, amount o galactose, fructose, glucose and sucrose were reduced while that of rhamnose, in contrast, was increased. Cellobiose was present in the starting fresh fruit although was not detected in the corresponding dehydrated product.

139. GLC-chromatograms of organic acids indicated the separation of 10 components from ripe fresh pulp of Sindihi banana as well as 9 ones from its corresponding dehydrated product. Only two components were identified as malic acid (20.40%) and citric acid (1.98%). Citric acid increased,while malic acid was decreased upon dehydration of fresh bananas probably due to processing conditions.

140.GLC chromatograms of organic acids separated from dehydrated pulp powder of white-fleshed "Baladi" guavas showed only 8 peaks. Malic and citric acid constituted 9.4 and 5.84% of the total organic acid.

141. GLC chromatograms of phenolic compounds indicated the separation of 14 peaks from ripe fresh pulp of Sindihi bananas as well as 20 peaks from its corresponding dehydrated product. Two principal components were not identified. Flavianic acid constituted the third major phenolic component (15.11%) followed by gentistic acid (7.36%), ferulic acid (5.73%), unknown (1.38%), unknown (1.27%) then salicylic acid (1.11%).

142. The identified phenolic compounds in the corresponding dehydrated banana products were syringic acid, ferulic acid, arbutin, flavianic acid, chlorogenic acid, caffeic-acid gallic acid, salcylic acid and hydroquinone.

143. GLC Chromatograms of phenolic compounds indicated the separation of 9 peaks from ripe fresh white-fleshed "Baladi" guavas as well as 16 peaks from its corresponding dehydrated product. Flavianic acid constituted the third major phenolic

compound (11.91%) followed protocatechuic acid (2.01%) ferulic acid (1.51%) then chlorogenic acid (0.56%).

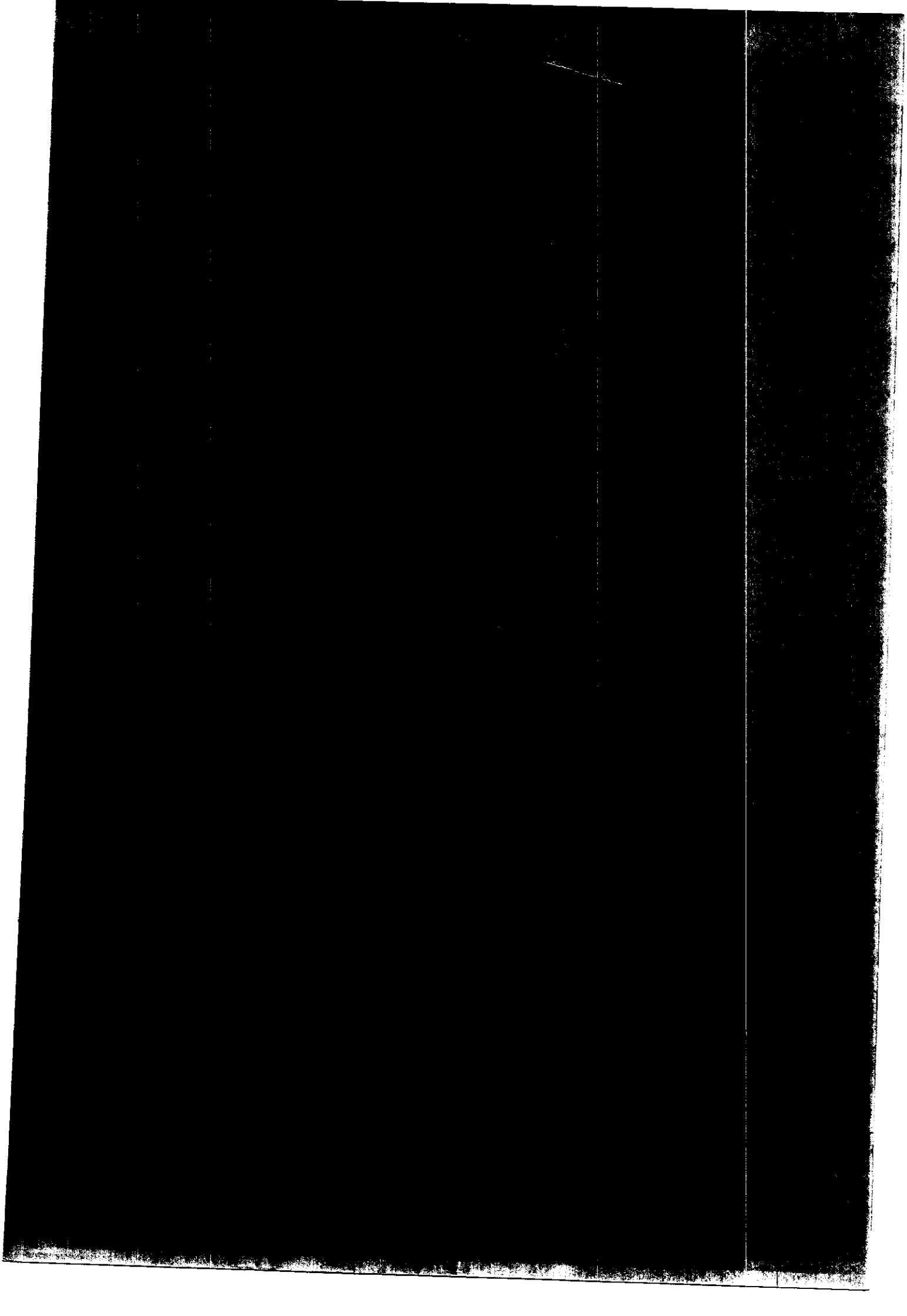
144. In the corresponding dehydrated guava product seven phenolic compounds were identified as p-coumaric (35.96%), syringic acid (20.39%), protocatechuic acid (7.32%), ferulic acid (3.50%), arbutin (3.02%), chlorogenic acid (1.11%) and hydroquinone (0.43%) of total phenolic compounds separated.

Part V: Utilization of dehydrated products in preparation of some food products:

145. In preliminary experimental trials, instant drinks (with water or milk), fruit-flavoured milk shakes milk-fruit-pudding, infant cereal-fruit foods, cereal flakes supplemental with dry fruits and ice-cream mixes were prepared using varying proportions of dry fruit powders or pieces as well as their rehydrated materials without or with different proportions of sugars (1 to 5%). Results, in general, were quite promising but further standarization procedure and modification in recipies are needed.

146. Organoleptic evaluation of jellies prepared using guava and banana dry products (after their rehydration) proved that they were acceptable although there no artificial flavours were added to the tested jellies.

147. Dehydrated rings of bananas or guava proved very successful when used as supplement for surface decoration and as mouth feel materials for the tested jellies prepared from rehydrated fruit suspensions and also those prepared from commercial jellies.



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LIST OF ABBREVIATION

A.D.	Since Christ was Born
A.R.	Analytical Reagent
atm.	Atmosphere
B.C.	Before Christ
B.P.	Boiling Point
°C	Centigrade
ca	About
cm	Centimeter
cv.	Cultivar
D	Dilution
Dept.	Department
dm	Decimeter
e.g.	For Example
et al.	and Others
°F	Fahrenheit
ft	Feet
g	Gram(s)
GC	Gas Chromatography
GLC	Gas Liquid Chromatography
hr	Hour
i.e.	That is (id est)
in situ	In Its Original Place
Inst.	Institute
I.R.	Infra Red
IU.	International Unit
kg	Kilogram(s)
lb/in^2	Pounds per Square Inch
M	Molar
m	Meter(s)
mg	Milligram(s)
min	Minute(s)
mm	Millimeter
MT	Metric Tons
mu	Millimicron
N	Normal

nm	Nanometer
per se	by or in it self
ppm	Part Per Million
p., pp.	Page(s)
R.H.	Relative Humidity
r.p.m.	Revolution Per Minute
RT	Retention Time
RTT	Relative Retention Time
Sec.	Second
TLC	Thin Layer Chromatograph
ug	Microgram
ul	Microliter
U.S.A.	United States of America
V	Volume
vs.	Versus
w	Weight
%	Per cent
	Greater than
	Greater than or Equal
	Less than
	Less than or Equal