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Retention of micronutrient content in selected perishable and non-perishable food samples at post processing stage

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Abstract
The retention of micronutrients in both perishable and non-perishable food items is critical for maintaining nutritional quality throughout storage, processing, and consumption. Perishable foods, such as fruits, vegetables, and dairy products, are prone to rapid nutrient degradation due to factors like temperature, humidity, and exposure to light. Methods of processing and preservation such as refrigeration, controlled atmosphere storage, and appropriate processing techniques should be employed to preserve their micronutrient content. Non-perishable foods, including grains, legumes, and canned goods, undergo various preservation processes, such as drying, roasting soaking, and freezing, which can affect their nutrient retention. Although these processes extend shelf life, use of inappropriate processing technique can reverse the result. The use of product specific and suitable strategies can help mitigate nutrient losses in non-perishable items.
There are numerous studies which focus on the processing of perishable and nonperishables food stuff so that they can be used for development of edible products. But still there is a research gap to identify which particular processing techniques are suitable for particular type of food considering its chemical and nutritional composition. Techniques which can be suitable for one food product can be harmful for the nutrient content of other type of food.
Micro nutrient content is of special concern in the contacts with processing techniques. As we all know that these minute amount of essential nutrients can get drastically affected by the processing techniques which include heat, acid alkali or excessive physical friction. Understanding the mechanisms of nutrient retention and employing appropriate preservation techniques, extensive research work should be conducted with individual food stuff experimenting with individual processing techniques so that their effects on micronutrient retention can be documented and used for further product development and food processing.

Keywords: processing techniques, micro nutrient content, retention, heat loss, product development

Introduction
Food is known to be a highly perishable substance in nature. In spite of taking all the precautions for post-harvest handling, processing of food is considered to be a more stable option. It pauses the undesirable changes in the wholesomeness, nutritive value and sensory qualities by controlling their chemical, physiological and microbial attributes. Most promptly food processing proves to be beneficial in improving the digestibility of foods and making some nutrients more available by altering its chemical and physical bonding.
The another perspective of processing techniques like soaking, blanching and drying cause loss of few heat and oxidation sensitive nutrients like vitamin C, folic acid, iron and sodium. According to Banker *et al.* (2004), losses of heat labile nutrients depend on the extent of heating and intensity of oxygen, pH and light. It is important to note that processing should be done within the recommended guidelines, as over processing destroys not only nutrient content but also taste and appearance. Micronutrients like vitamins and minerals are abundant in plant based foods. However, processing techniques can alter the micronutrient content and composition in the final product.

Methodology
The current experimental study was planned with the aim of examining the compatibility of few processing techniques on nutrient retention of selected food samples. Study was conducted

in three phases-1. Selection of perishable and nonperishable food products, 2. Preprocessing micronutrient estimations of raw food products, 3 Processing of selected food products 4. Post processing micronutrient estimations of selected food products. Perishable food samples (i.e. semolina, rice flakes, pearl millet and gingelly seeds) and nonperishable food samples (i.e. spinach, carrot, aonla, banana, lotus stem) were treated with the processing techniques which could improve the food acceptability without seriously affecting its nutritive value and diminishing the total food availability. Recommended guidelines were followed for while applying the suitable processing techniques. Blanching was applied on vegetables. They were plunged into boiling water (80 to 90ºC), and plunged into iced water to halt the process. The time duration was generally 2 to 4 minutes in total. Roasting was done by exposing the food material to the radiant heat of an open fire. It reduces the moisture content of the food sample and improves the keeping quality. Popping was done by using common salt as heating medium in an open iron pan, (grain to salt ratio of 1:10) at 240 to 260^{0}C for 6 to 8 minutes. Drying / dehydration involved the removal of water from the food material by using hot air oven. The all food samples were subjected to hot air oven drying at 60^{0}C except, the pearl millet sample was dried at 80^{0}C for one hour before they were popped.

Table 1: Processing of selected food products

1	Food product	Processing applied
2	Semolina	Roasted-Soaked (warm water for 1 hr)-oven dried (60ºC for 4-5 hrs)
3	Rice flakes	Roasted
4	Pearl millet	Blanched (30 sec)-Oven Dried (80 ºC for 1 hr)-Popped
5	Gingelly seeds	Roasted
6	Spinach	Blanched-Ground-Oven dried (60 ºC for 19-20 hrs)
7	Carrot	Blanched-Grated-Oven dried (60 ºC for 16-18 hrs)
8	Lotus stem	Blanched-Shrdded-Oven dried (60 ºC for 10-12 hrs)
9	Aonla	Sliced-Dried (60 ºC for 16-18hrs)
10	Banana	Sliced-Blanched-Dried (60 ºC for 16-18hrs)

All the samples were subjected to their micronutrient estimations (β carotene, vitamin C, folic acid, iron and sodium) at pre and post processing state. The standard method of nutrient estimations given by AOAC 2000 were followed for the analysis of β carotene, Vitamin C, folic acid, iron and sodium.

Table 2: Standard methods used for Micronutrient estimations

	Micronutrient	Method
1	β carotene	Column Chromatography and HPLC analysis of β carotenoidic extract (AOAC 2000)
2	Vitamin C	Titration method (AOAC 2000)
3	Folic acid	Microbial Assay method for Quantitative estimation HPLC method (AOAC 2000)
4	Iron	AAS analysis Method (AOAC 2000)
5	Sodium	AAS analysis Method (AOAC 2000)

The statistical analysis was done to check the significance of the effects of the processing techniques on the micronutrient content of food sample.

Results and Discussions

Retention of micronutrients in non-perishable food samples-Processing techniques applied on the semolina and rice flakes sample during the study was roasting. The data revealed that folic acid showed average amount of reduction of 7.4 per cent in semolina and 3.33 percent in rice flakes. However, in semolina higher reduction (14.29 per cent) was recorded in sodium content in comparison to iron (6.25 per cent). The loss in minerals was found to be 0.5 per cent in iron and 6.9 per cent in sodium content of rice flacks.

Table 3: Post processing retention of nutrients in semolina

Nutrients	Semolina (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
B carotene (µg/100g)	negligible	negligible	negligible
Vitamin C (mg/100g)	negligible	negligible	negligible
Folic Acid (µg/100g)	2.7±0.58	2.5±1.0	-7.41
Iron (mg/100g)	3.2±0.84	3.0±0.7	-6.25
Sodium (mg/100g)	1.4± 0.2	1.2 ±0.4	-14.29

Table 4: Post processing retention of nutrients in rice flakes

Nutrients	Rice flakes (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
βcarotene (µg/100g)	negligible	negligible	negligible
Vitamin C (mg/100g)	negligible	negligible	negligible
Folic Acid (µg/100g)	6.0±1.46	5.8±1.21	-3.33
Iron (mg/100g)	17.09±0.98	17.0±1.02	-0.53
Sodium (mg/100g)	3.01±1.73	2.8±0.71	-6.98

Table 5: Post processing retention of nutrients in gingelly seeds

Nutrients	Gingelly seeds (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	34.0±3.29	33.5±1.81	-4.41
Vitamin C (mg/100g)	Negligible	Negligible	Negligible
Folic Acid (µg/100g)	119.0±0.74	112±2.41	-5.8
Iron (mg/100g)	4.8±1.77	4.7±1.02	-2.08
Sodium (mg/100g)	Negligible	Negligible	Negligible

Table 6: Post processing retention of nutrients in pearl millet

Nutrients	Pearl millet (Mean ± SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	69.0±1.67	67.5±1.31	-2.17
Vitamin C (mg/100g)	0.0	0.0	0.00
Folic Acid (µg/100g)	48.0±2.77	46.2±3.0	-3.75
Iron (mg/100g)	6.7±1.36	6.2±0.9	-7.46
Sodium (mg/100g)	3.68±1.12	3.5±0.5	-4.89

As far as As gingelly seeds are concerned the data in table 5 shows the reduction in the amounts of two vitamins folic acid and β carotene content was accounted to be 5.8 per cent and 4.4 per cent, respectively. The iron content of the sample has also shown reduction of 2.08 per cent. The reason documented for the loss heat applied during the roasting of the oil seeds.

Table 6 unveils the reduction in the vitamin content to be 2.1 per cent for β carotene and 3.7 per cent for folic acid content in pearl millet. Similarly the minerals were also found to get affected by processing, as 4.8 per cent loss was observed in case of sodium and 7.4 per cent in iron content in pearl millet. The loss of nutrients could be attributed to the heat destruction occurred during popping processes as well as leaching of these nutrients during blanching.

Retention of micronutrients in perishable food samples: In the present research work the selected vegetables spinach leaves, carrot, lotus stem samples were blanched and dried. The thorough observation of the data of sample spinach (dried) exhibited reduction of 20.0 per cent in vitamin C content and 6.0 per cent in folic acid content. At the same time a slight increase was observed in β carotene (3.43 per cent) content of the spinach sample after processing.

Table 7: Post processing retention of nutrients in spinach

Nutrients	Spinach (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	1485.0±2.80	1536.0±4.01 (15360µg in 100 g dry powder)	+3.43
Vitamin C (mg/100g)	30.0±3.27	24.0±2.2 (240mg in 100g dry powder)	-20.00
Folic Acid (µg/100g)	116.0±1.66	109.0±2.0	-6.03
Iron (mg/100g)	1.03±0.10	1.0±0.31	-2.92
Sodium (mg/100g)	13.55±1.78	9.2±1.61	-32.10

Table 8: Post processing retention of nutrients in carrot

Nutrients	Carrot (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	1769.0±4.02	1645.4±3.9 (20,562µg in100g dry powder)	-7.0
Vitamin C (mg/100g)	7.0±2.85	5.31±1.2 (66.25mg in 100g dry powder)	-24.14
Folic Acid (µg/100g)	23.0±1.32	21.0±3.1	-8.6
Iron (mg/100g)	2.3±1.32	2.00±0.9	-13.0
Sodium (mg/100g)	15.8±1.91	8.30±1.0	-47.47

Table 9: Post processing retention of nutrients in carrot

Nutrients	Lotus stem (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	0.0	0.0	0.00
Vitamin C (mg/100g)	4.0±1.3	2.4±0.2 (4.4mg in 100g dry powder)	-40.0
Folic Acid (µg/100g)	0.0	0.0	0.00
Iron (mg/100g)	30.33±1.75	26.0±2.0	-13.6
Sodium (mg/100g)	229.0±1.32	180.0±4.7	-21.4

In carrot sample higher reduction was recorded in the vitamin C (24.14 per cent) followed by folic acid (8.6 per cent) and β carotene (7.0 per cent) content whereas in minerals, sodium was found to be reduced by 47.4 per cent and iron by 13.0 per cent in processed carrot sample. In lotus stem the food item was blanched, dried and then converted into a uniform power. The minerals present in the test sample were also reduced by 13.6 and 21.4 per cent, respectively in case of iron and sodium. This loss of nutrient could be attributed to the heat destruction during drying. *Values in parenthesis denote the values on dry weight basis.

Table 10: Post processing retention of nutrients in Banana

Nutrients	Banana (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	16.0±2.73	12.0±2.52 (48µg in 100g dry powder)	-25.00
Vitamin C (mg/100g)	5.0±1.97	3.2±1.0 (12.8mg in 100g dry powder)	-36.00
Folic Acid (µg/100g)	4.0±2.30	2.1±0.80	-47.50
Iron (mg/100g)	0.2±0.07	0.1±0.02	-50.00
Sodium (mg/100g)	12.93±0.74	9.7±1.42	-24.98

Table 11: Post processing retention of nutrients in Aonla

Nutrients	Aonla (Mean±SD)		
	Pre Processing	Post Processing	Per cent Difference
β carotene (µg/100g)	4.0±1.98	3.2±0.5 (16.0µg in 100g dry powder)	-20.00
Vitamin C (mg/100g)	498.0± 2.45	348.0±10.9 (1740mg in 100g dry powder)	-30.1
Folic Acid (µg/100g)	0.2±0.02	01.0	-50.00
Iron (mg/100g)	2.3± 4.20	1.8±0.42	-21.74
Sodium (mg/100g)	4.0±2.11	3.2±0.91	-20.0

The critical view of the data showed in table 10 depicts the substantial loss of vitamin C content i.e. 36.5 per cent followed by folic acid i.e.47.5 per cent and β carotene i.e. 25 per cent after drying. The iron and sodium content of the test sample of banana were recorded to be reduced by 50.0 per cent and 24.9 per cent in dried sample. The drying of aonla sample has also substantially reduced the vitamin C content (30.1 per cent) and β carotene (20.0 per cent) content. Sodium and iron content of the aonla were also found to be reduced by 20.0 per cent and 21.74 per cent, respectively.

Conclusion

Food processing proves to be beneficial in improving the digestibility of foods and making some nutrients more available by inactivating anti-nutrients. At the same time the processing techniques like soaking, blanching and drying cause loss of few heat and oxidation sensitive nutrients like vitamin C, folic acid, iron and sodium. It could be concluded that despite of few drawbacks in terms of destruction sensitive nutrients of the food samples application of the processing techniques and its significance in enhancing the physical, nutritional and microbial qualities of food samples cannot be overlooked.

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