FRUIT-BASED CONCENTRATED PRODUCTS, IRON FORTIFIED, INTENDED FOR PREVENTION AND DIET THERAPY OF IRON DEFICIENCIES OF VULNERABLE POPULATION GROUPS

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Abstract. *Enrichment of food products by micro-nutrients is an essential element of strategies against nutritional deficiencies, such as iron deficiency, especially, in populations within developing countries. The addition of a micro-nutrient has to be done on the basis of scientific researches, so that its concentration in product is optimal for correction of nutritional deficiency, but, at the same time keeping the sensorial properties of product (appearance, colour, taste and smell).*
This paper presents some results of researches made to obtain two fruit-based concentrated products (apricots, plums) fortified with iron. As fortification agents, ferrous sulphate, ferrous lactate and ferrous gluconate were used, and the fortification levels were of 4 mg/100 g in the end product and 6.5 mg/100 g, respectively. The increase of iron bio-availability in the human body and, at the same time, assurance of an optimal acidity of fruit-based concentrated products should be done by addition of ascorbic acid into their composition.
The fruit-based concentrated products fortified with iron were analysed from sensorial, biochemical and microbiological point of views. The used fortification agents have not modified the product sensorial characteristics (appearance, colour, taste and smell), in comparison with the control sample (jams non-fortified with iron).
The iron content of the fortified products with iron, achieved within the National Institute of Research&Development for Food Bioresources – IBA Bucharest, was determined through atomic absorption spectrometry (λ = 248.3 nm) from samples mineralised on dry way.
The iron content of fruit-based concentrated products fortified with iron varied in the range 4.27 – 7.05 mg Fe/100g.

Keywords*: iron, fortified, food, content*

Introduction

Enrichment of food products with micro-nutrients is an essential element of strategies against nutritional deficiencies, such as iron deficiency, especially, in populations within developing countries. The adding of one micro-nutrient has to be done on the basis of scientific researches, so that its concentration in product is optimal for correction of nutritional deficiency, but, at the same time keeping the sensorial properties of product [1].

At the international level, important researches on the development of iron fortification technologies of food products were made [2].

Although, in comparison with meat products, the processed fruits have lower iron content, nutritionists recommend them in diet-therapy of iron deficiencies. Researches achieved by nutritionists underline that, the value of a food product as iron source, is influenced much more by the chemical state of this element than by its total iron content.

High solubility, easy ionization and ferrous valence are properties which increase iron assimilation grade. In the case of fruits, due to ascorbic acid content, the trivalent iron is reduced to bivalent iron, which favours its bio-availability in human body [3].

THIS PAPER PRESENTS THE RESULTS OF SOME RESEARCHES MADE TO ACHIEVE TWO FRUIT-BASED CONCENTRATED PRODUCTS (APRICOTS, PLUMS) FORTIFIED WITH IRON: *"APRICOTS JAM WITH NUT, FORTIFIED WITH IRON", "PLUMS JAM FORTIFIED WITH IRON".*

Experimental

The experiments aimed at in order to obtain iron fortified food products, were made within the micro-production pilot plant of the National Institute of Research&Development for Food Bioresources – IBA Bucharest.

To obtain fruit-based concentrated products fortified with iron, we used the following raw materials and materials: apricots (*The best Hungary* variety*)*, plums (*Stanley* variety*)*, sugar, nut, ascorbic acid, ferrous sulphate, ferrous gluconate, ferrous lactate, glass jars of 370 mL and 220 mL capacity (Twist – off closing system).

In order to obtain food products fortified with iron, more experimental variants were performed, the variable factors being the following:

- iron fortification agent
- iron fortification level
- ascorbic acid fortification level

To achieve fruit-based concentrated products, fortified with iron, the following technological flow was used: raw materials, materials and packaging reception, sorting, washing, cleaning - division, product preparation, packaging preparation, dosing, closing, pasteurisation, cooling, conditioning of full jars, storage.

THE IRON CONTENT OF THE FORTIFIED PRODUCTS WITH IRON, ACHIEVED WITHIN THE NATIONAL INSTITUTE OF RESEARCH&DEVELOPMENT FOR FOOD BIORESOURCES – IBA BUCHAREST, WAS DETERMINED THROUGH ATOMIC ABSORPTION SPECTROMETRY (Λ = 248.3 NM), FROM SAMPLES MINERALISED ON DRY WAY [4].

RESULTS AND DISCUSSION

Fortification of food products is legislated through *REGULATION (EC) no. 1925/2006 of EUROPEAN PARLIAMENT AND COUNCIL*, on 20 December 2006. This document specifies: requirements concerning the addition of vitamins and minerals, restrictions concerning the addition of vitamins and minerals, and vitamins and minerals sources which can be added in food products.

Since iron deficiency and feripive anaemia have an increased incidence among vulnerable population groups (children, teen-agers, pregnant women, etc.), the achievement of some fruit-based processed products, fortified with iron, represents a necessity.

Taking into consideration all these aspects, our researches were performed at laboratory level and we achieved two fruit-based processed products, fortified with iron: *"Apricots jam with nut, fortified with iron"* and *"Plums jam fortified with iron"*

At the same time, we achieved *control samples* of fruit-based processed products (products unfortified with iron).

The fruit varieties used in experiments have superior sensorial characteristics (appearance, taste, flavour) and have a complex biochemical composition, excelling in glucids, vitamin C, minerals and ß – carotene content (only apricots).

Figure 1. Apricots – The best *Hungary* variety

Figure 2. Plums - *Stanley* variety

Table 1

Biochemical analysis of apricots – The best Hungary variety

Biochemical characteristics	Results
Dry soluble solids (°Brix)	12.6
Titratable acidity (g malic acid/100 g)	1.15
Soluble glucids (%)	9.85
Proteins (%)	0.82
Lipids (%)	0.1
ß–carotene (mg/100 g)	2.25
Ascorbic acid (mg/100 g)	12.45
Ash (%)	0.67
Iron (mg/100 g)	0.60

Table 2

Biochemical analysis of plums – *Stanley* variety

Biochemical characteristics	Results
Dry soluble solids (°Brix)	17.2
Titratable acidity (g malic acid/100 g)	0.85
Soluble glucids (%)	14.10
Proteins (%)	0.72
Lipids (%)	0.20
Pectic substances (%)	0.92
Ascorbic acid (mg/100 g)	14.15
Ash (%)	0.54
Iron (mg/100 g)	0.42

DIRECTIVE 2006/125/EC OF EUROPEAN COMMUNITY COMMISSION ON 5 DECEMBER 2006, CONCERNING CEREAL-BASED PREPARATIONS AND FOOD PRODUCTS FOR CHILDREN, INTENDED FOR SUCKERS AND INFANTS, IMPOSES A MAXIMUM LIMIT OF IRON ADDITION IN ORDER TO FORTIFY: 3 MG FE/100 KCAL. TAKING INTO CONSIDERATION THIS RECOMMENDATION, IN THE CASE OF THE TWO PRODUCTS "APRICOTS JAM WITH NUT, FORTIFIED WITH IRON" AND "PLUMS JAM FORTIFIED WITH IRON" WE ACHIEVED THE FOLLOWING FORTIFICATION LEVELS: 4 MG FE/100 G PRODUCT AND 6.5 FE MG/100 G PRODUCT.

To increase iron bio-availability in the human body and, concomitantly, to ensure optimal acidity of fruit-based concentrated products, fortified with iron, ascorbic acid was added in their composition, in the following concentrations:

- 70 mg ascorbic acid/100 g product, 95 mg ascorbic acid/100 g product (in the case of product *"Apricots jam with nut, fortified with iron"*)
- 90 mg ascorbic acid/100 g product, 125 mg ascorbic acid/100 g product (in the case of product *"Plums jam fortified with iron"*)

For each fruit-based concentrated product fortified with iron we achieved, besides control samples (concentrated products, unfortified with iron), 12 experimental variants (3 iron fortification agents, 2 iron fortification levels and 2 ascorbic acid fortification levels). All of them were analysed from the sensorial, biochemical and microbiological point of views.

The sensorial analysis of products *"Apricots jam with nut, fortified with iron"* and *"Plums jam fortified with iron"* proved that in the case of all experimental variants, the used fortification agents (ferrous sulphate, ferrous lactate, ferrous gluconate) have not determined modification of sensorial characteristics (appearance, colour, taste and smell), in comparison with the control samples (jams unfortified with iron). Thus, the two fruit-based concentrated products, fortified with iron (fortification agents: ferrous sulphate, ferrous lactate, ferrous gluconate) comply

with the provisions of SR 3183:1990 „Jams" from the sensorial point of view.

According to the biochemical analysis, the product *"Apricots jam with nut, fortified with iron"* achieved in 12 experimental variants has high nutritional value, excelling through its content in soluble glucids, minerals, ß – carotene and ascorbic acid.

The iron content of the product *"Apricots jam with nut, fortified with iron"* is in the range 4.48–7.05 mg/100 g, and that of ascorbic acid in the range 21.58–32.75 mg/100 g. After assessing the sensorial and nutritional characteristics of this product, we selected, as optimal variants, for each fortification agent, the following:

- V4 (fortification agent ferrous sulphate)
- V8 (fortification agent ferrous gluconate)
- V12 (fortification agent ferrous lactate)

Table 3

Biochemical analysis of product *"Apricots jam with nut, fortified with iron"*

Biochemical characteristics	V4	V8	V12
Dry soluble solids (°Brix)	68.0	68.0	68.1
Titratable acidity (g malic acid/100 g)	1.44	1.46	1.42
Soluble glucids (%)	64.14	64.00	64.27
Proteins (%)	1.35	1.29	1.30
Lipids (%)	2.24	2.14	1.94
Pectic substances (%)	0.30	0.28	0.25
ß–carotene (mg/100 g)	1.60	1.51	1.42
Ash (%)	0.608	0.622	0.603
Iron (mg/100 g)	6.98	7.01	7.05
Potassium (mg/100 g)	271.9	250.1	267.15
Calcium (mg/100 g)	12.60	12.15	13.03
Magnesium (mg/100 g)	10.03	9.42	10.21
Ascorbic acid (mg/100 g)	30.42	31.67	32.75

According to the biochemical analysis, the product *"Plums jam fortified with iron"*, achieved in 12 experimental variants has high nutritional value, excelling through its content in soluble glucids, minerals and ascorbic acid.

The iron content of the product *"Plums jam fortified with iron*" is in the range 4.27 – 6.80 mg/100 g, and that of ascorbic acid in the range 28.95 – 40.15 mg/100 g. After assessing the sensorial and nutritional characteristics of this product we selected, as optimal variants, for each fortification agent, the following:

- V4 (fortification agent ferrous sulphate)
- V8 (fortification agent ferrous gluconate)
- V12 (fortification agent ferrous lactate)

Table 4

Biochemical analysis of product *"Plums jam fortified with iron"*

Biochemical characteristics	V4	V8	V12
Dry soluble solids (°Brix)	68.15	68.00	68.10
Titratable acidity (g malic acid/100 g)	1.57	1.50	1.55
Soluble glucids (%)	64.92	64.65	64.83
Proteins (%)	0.51	0.55	0.44
Pectic substances (%)	0.57	0.61	0.53
Ash (%)	0.405	0.416	0.400
Iron (mg/100 g)	6.80	6.75	6.70
Potassium (mg/100 g)	153.15	152.28	154.45
Calcium (mg/100 g)	11.10	10.85	11.42
Magnesium (mg/100 g)	8.42	8.31	8.18
Ascorbic acid (mg/100 g)	39.55	40.15	39.27

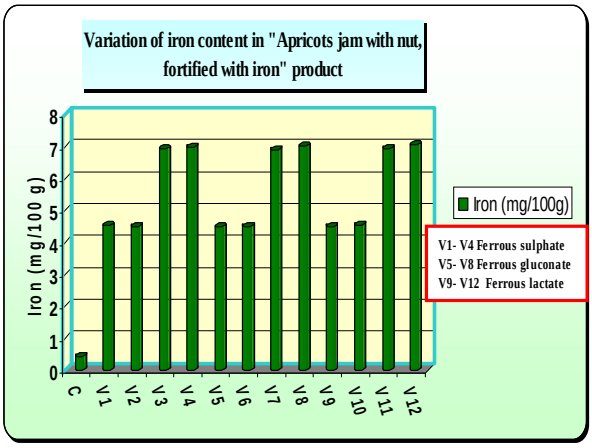

Figure 3. Variation of iron content in *"Apricots jam with nut, fortified with iron"* product

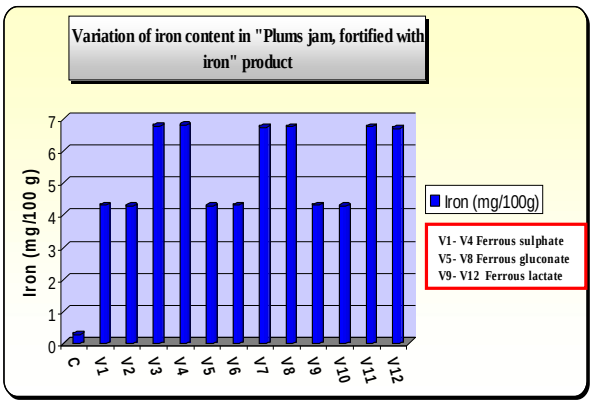

Figure 4. Variation of iron content in *"Plums jam fortified with iron"* product

Figure 5. "Apricots jam with nut, fortified with iron"

Figure 6. "Apricots jam with nut, fortified with iron" – experimental variant V1 (4 mg Fe/100 g, fortification agent – ferrous sulfate)

Figure 7. "Plums jam fortified with iron"

Figure 8."Plums jam fortified with iron" – experimental variant V2 (4 mg Fe/100 g, fortification agent – ferrous sulphate)

The microbiological analysis has shown that fruit-based concentrated products, fortified with iron, achieved in 12 experimental variants and control samples, are comply with the legislation in force from the microbiological point of view.

Conclusions

1. At the National Institute of Research&Development for Food Bioresources – IBA Bucharest we achieved two fruit-based processed products, fortified with iron (*"Apricots jam with nut, fortified with iron"* and *"Plums jam fortified with iron"*), we used ferrous sulphate, ferrous lactate and ferrous gluconate as fortification agents of the achieved products.
2. The iron content of the achieved fruit-based concentrated products varied in the range 4.27 – 7.05 mg Fe/100g.
3. The used fortification agents have not determined modifications of sensorial characteristics (appearance, colour, taste and smell), of the fruit-based concentrated products, fortified with iron, in comparison with those of control products.

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