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Acceptability and Nutrient Content of Wet Noodles Fortified with Inorganic or Organic Iron and Provitamin A from Pumpkin (Cucurbita moschata)

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ABSTRACT

Background: *Iron fortification of wet noodles is a choice among many others, to reduce iron deficiency anemia. Organic and inorganic iron interact with provitamin A. An experiment was conducted to fortify wet noodles with organic and inorganic iron and provitamin A from pumpkin, and to study its effect on acceptance and its iron and provitamin A content.*

Methods: *Six groups were used in this experiment to test optimal level of iron fortification (100 ppm, 150 ppm, 200 ppm of* $FeSO_4$ *or organic iron). As for pumpkin, 10%, 15% and 20% were used. To test iron and provitamin A content, 5 groups were employed: wet noodle alone, wet noodle + (*$FeSO_4$*), + (organic Fe), + (*$FeSO_4$ *& pumpkin), and + (organic Fe & pumpkin) respectively. Data were evaluated by one-way ANOVA and continued by Duncan's test with 95% CI.*

Result: *Noodle fortified with 200 ppm iron was acceptable in term color, taste and texture. Adding 15% pumpkin improved texture optimally compared to 10% and 20%. In term color and taste, 10%, 15% and 20% pumpkin addition gave similar acceptance. Fortification of iron and provitamin A from pumpkin didn't affect the moisture, protein, fat, fiber, and carbohydrate content but increased iron, ash and betacarotene content. Highest content of iron and provitamin A were found in noodles + (FeSO4 + pumpkin) and noodles + (organic Fe + pumpkin).*

Conclusion: *Iron and provitamin A fortified wet noodles can serve as a choice for eliminating iron deficiency anemia in Indonesia. Further studies to see the bioavailability and effectiveness of fortified wet noodles to reduce anemia are needed.*

Keywords: *Fortification, organic iron, inorganic iron, provitamin A pumpkin, wet noodles*

ABSTRAK

Daya terima dan kandungan gizi mie basah yang difortifikasi zat besi anorganik dan organik serta provitamin A labu kuning (Cucurbita moschata)

Latar belakang: *Fortifikasi mie basah merupakan salah satu pilihan untuk menanggulangi permasalahan anemia gizi besi. Besi organik dan anorganik dapat berinteraksi dengan provitamin A. Penelitian ini bertujuan untuk memfortifikasi mie basah dengan besi organik dan anorganik serta provitamin A labu kuning, dan untuk mengetahui pengaruhnya terhadap daya terima, kadar besi dan provitamin A pada mie basah.*

Metode: *Enam perlakuan digunakan dalam penelitian untuk optimasi kadar besi fortifikan (100 ppm, 150 ppm, dan 200 ppm* $FeSO_4$ *atau Fe organik). Labu kuning yang digunakan 10%, 15%, dan 20%. Untuk mengetahui kadar besi dan provitamin A digunakan 5 perlakuan: mie basah, mie basah + (*$FeSO_4$*), + (Fe organik), + (*$FeSO_4$ *& labu kuning), dan + (Fe organik & labu kuning). Data dianalisis dengan one-way ANOVA dan dilanjutkan dengan uji Duncan dengan 95% CI.*

Hasil: *Mie yang difortifikasi dengan 200 ppm zat besi dapat diterima dari sisi warna, rasa dan tekstur. Penambahan labu kuning 15% memberikan tekstur yang lebih baik dibandingkan 10% dan 20%. Dari sisi warna dan rasa, penambahan labu kuning 10%, 15% dan 20% mempunyai daya terima yang sama. Fortifikasi besi dan provitamin A labu kuning tidak mempengaruhi kadar air, protein, lemak, serat dan karbohidrat tetapi meningkatkan kadar besi, abu dan betakaroten. Kadar besi dan provitamin A tertinggi terdapat pada mie + (*$FeSO_4$ *+labu) dan mie + (Fe organik + labu).*

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Simpulan: *Mie basah yang difortifikasi besi dan provitamin A berupa labu kuning dapat menjadi alternatif untuk mengatasi anemia gizi besi di Indonesia. Diperlukan penelitian lanjutan untuk mengetahui bioavailabilitas dan keefektifan mie yang difortifkasi untuk mengurangi anemia.*

PENDAHULUAN

Iron deficiency anemia remains a major health problem in Indonesia. The prevalence of iron deficiency anemia among children under five years in Indonesia and at the age of 15-49 years is 48% and 26% respectively.[1] This problem can be approached in several ways, one of which is by iron fortification in food. However, the success of iron fortification depends on several factors i.e. the type of food vehicle and its bioavailabity. Food vehicle must be well and widely accepted and consumed so that it can provide a large and efficient geographic coverage.

In Indonesia, noodle has been an alternative staple food after rice.[2] As a second staple food it has penetrated almost all segments of population, covering not only households of diverse geographical area (village and cities) but also socio economic levels.[3] The acceptability of noodle has made it into a potential food vehicle for iron fortification targeted to vulnerable group in Indonesia.

Bioavailability of iron in fortified food depends on the type of iron source and its interaction with other nutrient such as provitamin A betacarotene or vitamin A. There are two types of iron used in fortification i.e. inorganic and organic iron. A study in livestock showed that organic iron is more bioavailable than inorganic iron.[4] However, the bioavailability of inorganic iron in human and animal can be improved by its interaction with betacaroten or vitamin A.[5] Betacaroten or vitamin A can bind iron liberated during the digestive process and forms a complex that acts as a chelating agent, preventing the inhibitory effect of phytates and polyphenols on nonheme iron absorption.[6,7,8]

Pumpkin *(Cucurbita moschata)* is potential source as natural provitamin A that contains 1569 µg betakaroten/ 100 gram.[9] It is locally available and well grown vegetable in village, but not much consumed. Therefore can be used in combination with inorganic iron to increase its bioavailability. A natural vitamin A has been shown to be more effective than retinyl palmitate.[10]

This experiment was conducted to fortify wet noodles with organic and inorganic iron and provitamin A from pumpkin, and to study its effect on panelist acceptance and its nutrient content (moisture, protein, fat, carbohidrat, fiber, ash, iron and betacarotene).

MATERIAL AND METHODS

Inorganic iron, 20% $FeSO_4$ was obtained from Sigma, and organic Fe (with 10.9% Fe). Fresh pumpkin was obtained from local market and pumpkin powder was prepared by drying fresh-sliced pumpkin at moderate temperature and grounding the dried pumpkin. High protein wheat flour, eggs, and salt were obtained from local food supplier. HgO-K_2SO_4, H_2SO_4, NaOH, boric acid, HCl, dietil eter, petroleum eter, and 96% alcohol were purchased from Merck. All materials used to make the wet noodles are from the same batch which was prepared prior to experimental execution.

This experiment was conducted in 2 stages. The first one is fortification of wet noodles with iron and pumpkin as the source of provitamin A and its acceptability with different content iron and provitamin A. The second stage is the determination of nutrient content of the fortified wet noodles. Determination of optimal types of iron in fortified or provitamin A in wet noodle was carried out as shown in Figure 1.

For optimal provitamin A fortification, wheat flour was firstly mixed with steamed pumpkin at 10%, 15% dan 20%. The amount of water added to the dough of steamed pumpkin was adjusted so that it gave the same texture and water content. The resulting wet noodle is tested organoleptically by 20 trained panelist for colour, taste and texture acceptance.[11]

The second stage was conducted to determine nutrient content of the fortified wet noodles made by the same procedure and result in the first stage of experiment. Moisture, carbohydrate, protein, fat, ash, crude fiber, iron and betacarotene were determined according to established methods.[12-15] Completely randomized designed was used in this experiment. Optimal iron fortification was tested using inorganic Fe ($FeSO_4$) or organic Fe with iron level of 100 ppm, 150 ppm, 200 ppm.

To test the nutrient content of the fortified wet noodles, 5 treatments were employed i.e: 1) control noodles without iron, 2). Fortified wet noodles with inorganic iron ($FeSO_4$), 3) Fortified wet noodles with organic Fe, 4) Fortified wet noodles with inorganic iron and pumpkin, and 5) Fortified wet noodles with organic Fe and pumpkin. Data were evaluated by one-way ANOVA and continued by Duncan's test with 95% confidence level.

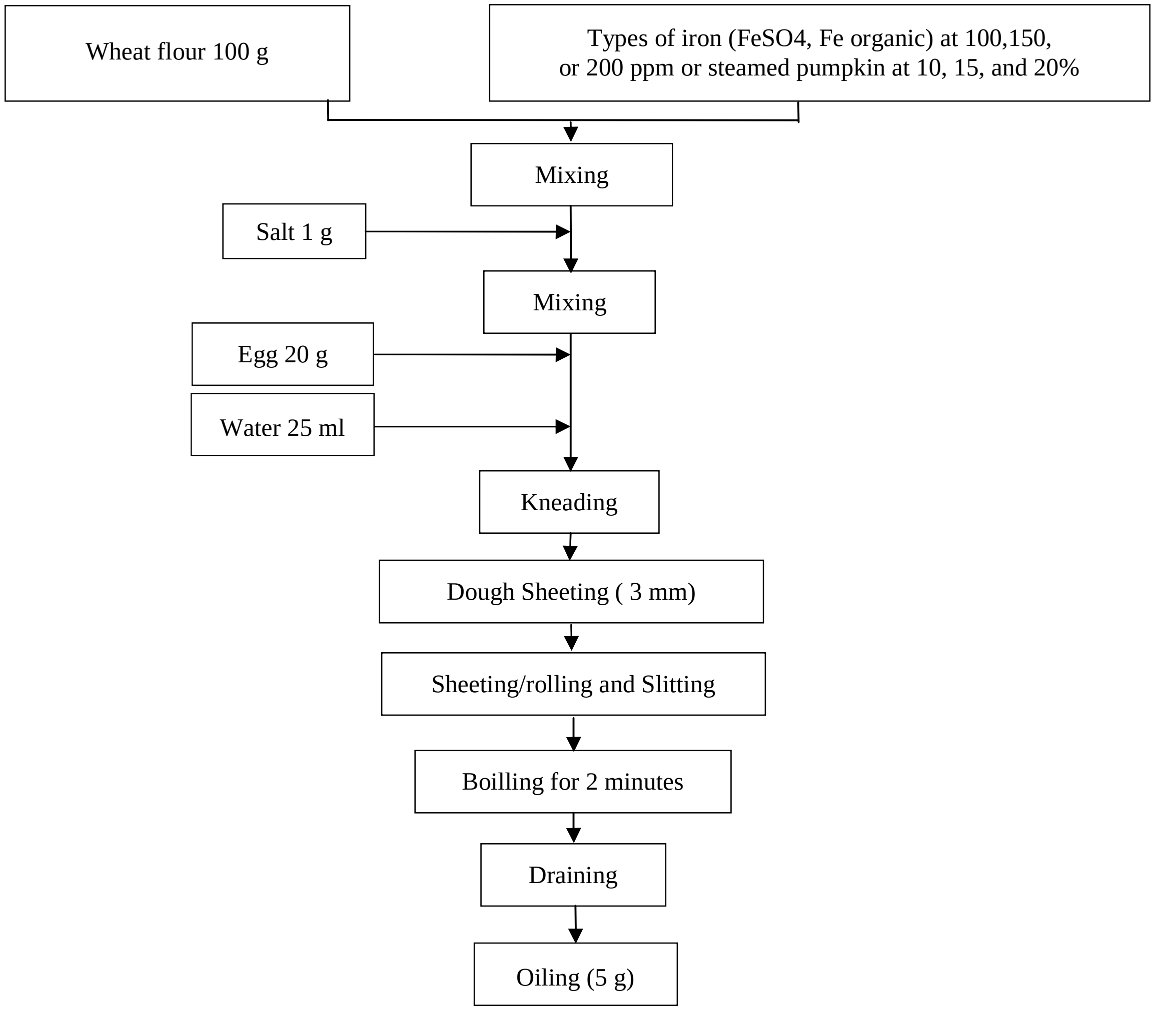

Figure 1. Processing steps in wet noodle making

RESULTS

Acceptability fortified wet noodle with iron and provitamin A from pumpkin

The results of optimal iron determination in wet noodles (Figure 2) showed that up to 200 ppm of both types of organic and inorganic iron had acceptable colour, taste and texture.

The results of optimal pumpkin determination in wet noodles showed that incorporation of 15% pumpkin improved the texture of wet noodles (Figure 3).

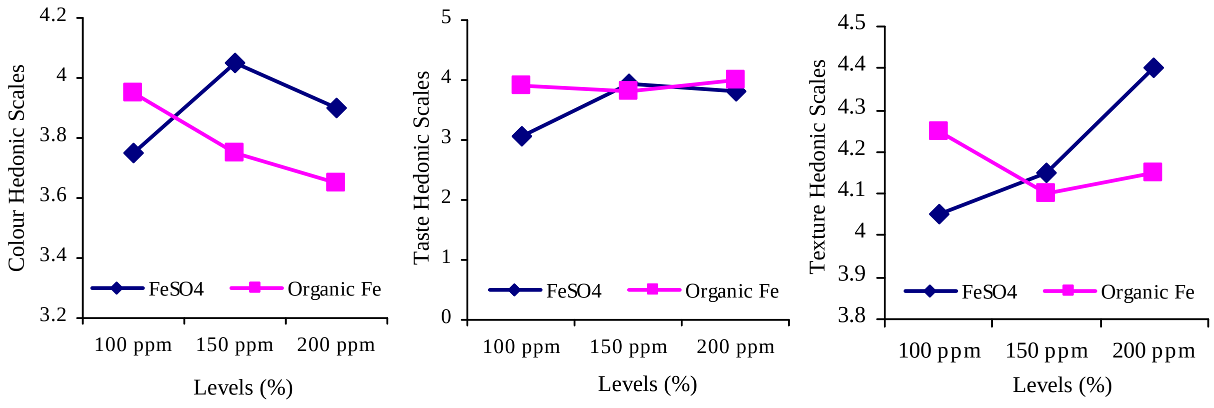

Figure 2. Acceptability of wet noodles fortified with iron

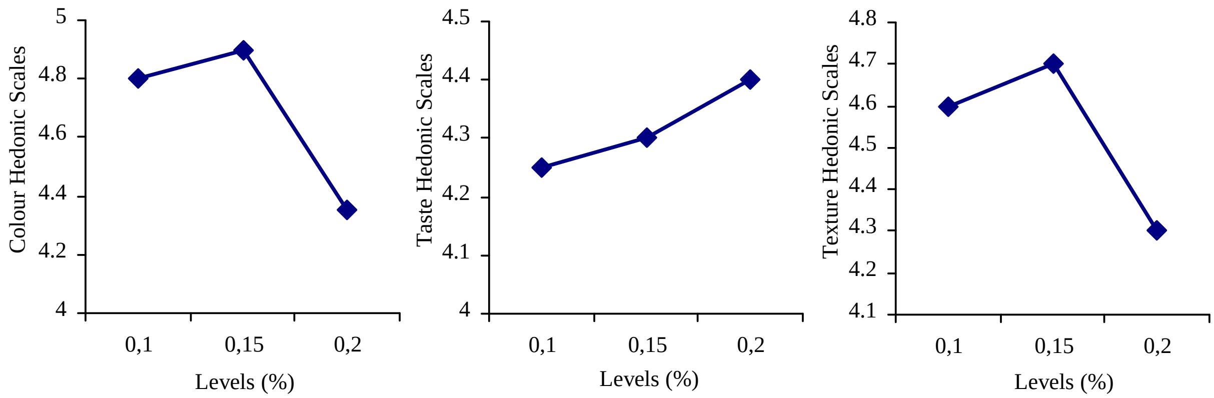

Figure 3. Acceptability of wet noodles fortified with provitamin A pumpkin

Nutrient content of wet noodle fortified with iron and provitamin A pumpkin

Nutrient content of fortified wet noodles presented on Tables 1.

The results showed that fortification of iron and provitamin A from pumpkin didn't increased the moisture, carbohydrate, protein, fat and fiber content. The ash content was affected by fortification of iron and provitamin A pumpkin (p = 0,005). The highest content of ash was found in wet noodles fortified with (organic Fe + pumpkin).

Iron content

The iron content of fortified wet noodles was 15,08-41,08 ppm (Figure 4). Fortification of iron and provitamin A pumpkin increased significanly the iron content (p=0,0001). The highest content of iron were found in noodles fortified with $FeSO_4$ and noodles with ($FeSO_4$ + pumpkin).

Table 1. Nutrient content of fortified wet noodles

Perlakuan	Moisture (%)	Cabohydrate (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)
No Fortification	62,86 ± 0,95	26,37 ± 0,93	6,83 ± 0,29	3,54 ± 0,16	0,40 ± 0,03^{bc}	0,68 ± 0,24
$FeSO_4$	64,26 ± 1,86	24,86 ± 2,22	6,95 ± 0,38	3,55 ± 0,30	0,39 ± 0,04^{c}	0,50 ± 0,06
Organic Fe	61,74 ± 1,45	27,08 ± 1,60	7,09 ± 0,26	3,68 ± 0,25	0,42 ± 0,01^{bc}	0,72 ± 0,18
$FeSO_4$ + Pumpkin	63,66 ± 0,80	25,77 ± 1,04	6,54 ± 0,33	3,59 ± 0,26	0,44 ± 0,01^{ab}	0,53 ± 0,03
Organic Fe + Pumpkin	62,14 ± 3,23	27,11 ± 3,61	6,66 ± 0,29	3,63 ± 0,22	0,47 ± 0,04^{a}	0,56 ± 0,05
ANOVA	p=0,335^{NS}	p=0,540^{NS}	p=0,149^{NS}	p=0,924^{NS}	p=0,005*	p=0,144^{NS}

Description: Different letter indicate significanly different in Duncan's test 95% CI

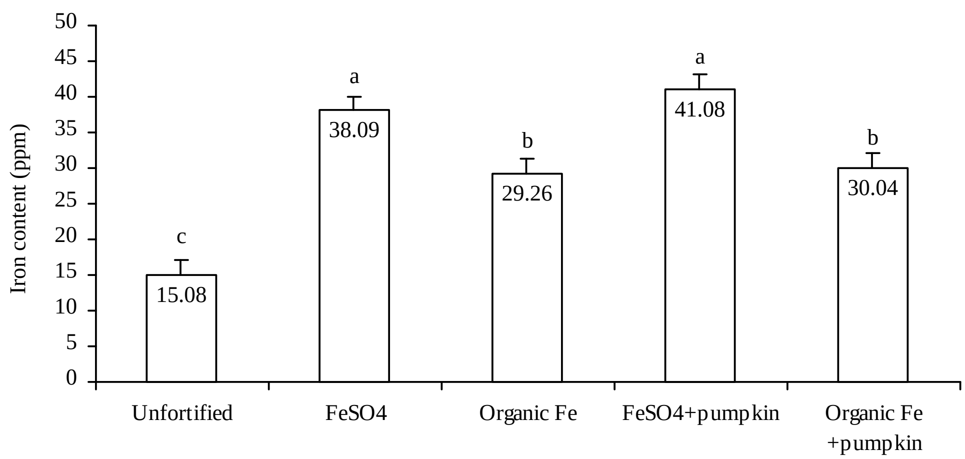

Figure 4. Iron content of the fortified wet noodles

Betacarotene content

The betacarotene of wet noodles was affected by fortification of iron and provitamin A pumpkin (p=0,0001). The betacarotene content of fortified wet noodles was 26,21-35,65 ppm (Figure 5). The highest content of betacaroten were found in noodles fortified with ($FeSO_4$ + pumpkin) and noodles with (organic Fe + pumpkin).

DISCUSSION

The results of optimal iron determination in wet noodles showed that up to 200 ppm of both types of iron fortified in wet noodles (organic iron and inorganic iron) had acceptable colour, taste and texture. Addition of 15% pumpkin improved significanly the texture of wet noodles. On the basis of these results, the second stage of experiments used 200 ppm iron and 15% pumpkin. The results showed that fortification of iron and provitamin A pumpkin didn't affect significanly the moisture content of wet noodles. The fortified wet noodles have moisture content of 61,74%-64,26%. Inorganic iron or organic iron has very low moisture content, therefore the addition of 200 ppm iron didn't affect the moisture of wet noodles. Addition of steamed pumpkin also didn't affect the moisture of wet noodles. although pumpkin has high moisture content. This was due to the addition of water to the dough to obtain the same consistency and moisture content.

The protein content is in accordance with Indonesian National Standard (SNI) of wet noodle which requires minimum of 3% protein content in wet noodles.[16] Fortification of iron and provitamin A pumpkin didn't affect the protein content because the pumpkin has low protein content i.e. 1,1% and no protein in iron.[9] Fortification of iron and pumpkin didn't affect the fat content of wet noodles because iron because pumpkin has low fat content of 0,5 % and no fat in iron.[9]

Fortification of iron and pumpkin didn't affect significanly the carbohydrate content of wet noodles because 70% of carbohydrate content of wet noodle is found in the wheat flour, and pumpkin has a very low carbohydrate content. The ash content of pumpkin fortified wet noodle is higher than other fortified noodles because pumkin contains 1.2% ash.[9] Fortification of 15% pumpkin has added 0,18% ash content into wet noodles. Addition of 200 ppm iron ($FeSO_4$ or organic iron) didn't increase noodle ash content as ash consisted of various minerals. 200 ppm iron being used is too small compared to total ash content of the noodles i.e. 0.40%.

Addition of iron increased iron content of wet noodles. However, iron content of iron fortified noodles was lower than the actual iron added. $FeSO_4$ contains 20% iron [17] and organic iron Organic iron contains 10,9% iron. Inorganic $FeSO_4$ contributed 24,01 ppm and organic iron organic iron contributed 15,17 ppm iron into wet noodles. Therefore, the iron loss in the $FeSO_4$ and Organic iron fortified wet noodles were 39,98% and 30,41% respectively. The loss was due to boiling step in wet noodle making as iron is readily soluble in water.[18]

Fortification of iron and pumpkin didn't affect the fiber content of wet noodles because pumpkin only contained 2,7% fibres[9] and no fibre in iron. The provitamin A pumpkin didn't increase iron content of wet noodles because iron content of pumpkin is low i.e. 0,7 mg/100 g and iron content of wheat flour is 5 mg/100 g.

The control unfortified wet noodles contained 26,05 ppm betacarotene which came from the yellow egg as component of wet noodles. Addition of inorganic and organic iron to the wet noodles did not affect betacarotene content. However, addition of pumpkin increased betacarotene content in the iron fortified wet noodles as pumpkin contains 1569 µg betacarotene/100 g.

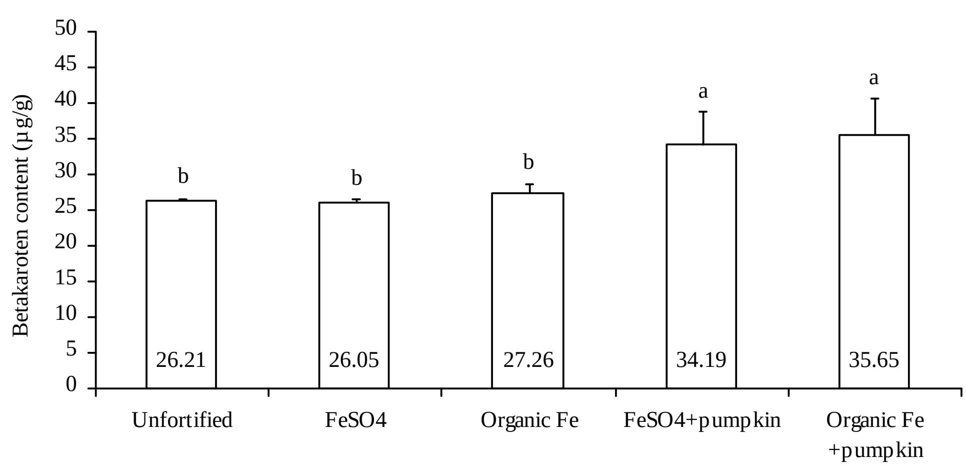

Figure 5. Betacarotene content of the fortified wet noodles

The processing technique of wet noodles is simple and straight forward and can be done manually. Wet noodles are produced by home industries and sold by food vendors for a variety of home and street food cooking in Indonesia. Therefore, its acceptibility and consumption pose no constraint. Increase ash, iron and betacarotene content of wet noodles showed the succes of iron (organic and inorganic) and provitamin A pumpkin fortification in wet noodles. This fortified wet noodles is a potential vehicle for iron fortified food and further research is set to be done to test its bioavailability in *in vivo* laboratory animals and ultimately to iron vurnerable groups.

CONCLUSION

Fortification of 200 ppm iron in wet noodles as inorganic iron ($FeSO_4$) or organic iron (Organic iron) produced acceptable colour, taste and texture. Addition of 15% pumpkin improved significanly the texture of wet noodles. Fortification of iron and provitamin A pumpkin didn't affect significanly the moisture, protein, fat, fiber, and carbohydrate content of wet noodles but significantly increased the iron, ash and betacarotene content.

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