Accelerated Shelf Life Evaluation of Instant Noodles Made with Fortified Flour

Summary of Findings

Background

In 2013 the Food Fortification Initiative (FFI) commissioned the Food Innovation and Resource Centre (FIRC) of the Singapore Polytechnic to study the impact of fortifying flour with iron on the shelf life of instant noodles made with the fortified flour. The study was in response to questions in Asian countries about whether wheat flour fortification caused negative organoleptic changes in Asian wheat flour foods. The results of this study should be considered together with studies that assessed organoleptic changes to other common Asian wheat flour foods. The results of studies undertaken in 2009 have been compiled by FFI in a report available on FFI's website[1] and summarised in an article published by Cereal Foods World.[2]

The accelerated shelf life evaluation was co-funded by the Micronutrient Initiative, Muhlenchemie, and the FFI.

Methodology

The objective of the study was to assess the impact on the shelf life of instant noodles made with flour fortified with different iron compounds. The study thus assessed physical and chemical properties and sensory attributes of fortified and non-fortified noodles. It then estimated the shelf life of instant noodles by adopting the Accelerated Shelf Life Test model.

The study compared instant noodles made from flour fortified with electrolytic iron, ferrous fumarate, encapsulated ferrous fumarate and sodium iron EDTA and non-fortified flour. The iron fortification premix, which was donated by Muhlenchemie, provided 60ppm of iron through the four iron compounds. 60ppm of iron is the amount recommended by WHO in the form of ferrous fumarate or sulphate for countries where consumption of wheat flour is <150g/capita/per day. At these consumption levels, WHO does not recommend use of electrolytic iron and only 40ppm of iron in the form of sodium iron EDTA[3], but it was necessary to provide the same amount of iron in all sample arms.

Instant noodles were made with the four types of iron-fortified flour and non-fortified flour. Control samples were stored at low temperature and humidity while test samples were stored in four different temperature and humidity conditions representing normal commercial storage conditions in Asian counties and elevated temperature and humidity conditions. Throughout the study period, which lasted for a total of simulated 52 weeks, samples were tested for iron content, peroxide and free fatty acid content as measures of rancidity, pH, moisture and colour. Sensory evaluation was also undertaken comparing test samples against control samples.

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[1] http://www.ffinetwork.org/plan/documents/AsiaFoodImpact.pdf
[2] Issue Sept-Oct 2013, Vol. 58, No.5
[3] WHO Recommendations on Wheat and Maize Flour Fortification 2009.
http://www.who.int/nutrition/publications/micronutrients/wheat_maize_fortification/en/

Main Findings

- Shelf life of all noodles deteriorated with rising storage temperatures and humidity and in general shelf life of noodles made with fortified flour was lower than that of noodles made with non-fortified flour. However shelf life of instant noodles made with flour fortified with all types of iron, except sodium iron EDTA, exceeded 12 months (industry standard) when stored at 30°C or less. At storage conditions of 35°C and 40°C no instant noodles had a shelf life of more than 12 months, including non-fortified noodles. Shelf life was assessed on the basis of flavour, which was impacted in particular by rancidity.
- Iron, from all forms of iron fortificant tested, was retained in the noodles for at least 30 weeks (duration of the assessment). An anomaly in the study results suggests a fall in iron content from ferrous fumarate when stored at 40°C.
- Peroxide and free fatty acid content, indicators of rancidity, increased with time and temperature in all samples of instant noodles. The difference from non-fortified noodles was only statistically significant for the free fatty acid content of noodles made with electrolytic iron and sodium iron EDTA if stored at 40°C however.
- No or minimal changes in pH, moisture content or colour were detected between the fortified and non-fortified noodles and noodles fortified with different iron fortificants. The most significant finding was that noodles made with iron fortified with sodium iron EDTA were generally darker than other noodles and non-fortified noodles had the lightest appearance.
- Sensory evaluation tests assessed appearance, texture, and flavour, compared to control noodles stored at low temperatures. The tests recorded a decline in all parameters with time, including in non-fortified noodles. The greatest decline was seen in noodles made with sodium iron EDTA fortified flour, in particular in relation to appearance (noodles were darker) and flavour (related to rancidity). Noodles made with flour fortified with electrolytic iron scored second worst at 35 weeks in terms of flavour. These results are in accordance with the quantitative assessment of peroxide values and free fatty acids as indicators of rancidity.
- The shelf life estimation indicated that the flavour of noodles made with ferrous fumarate fortified flour was most affected by temperature changes. Encapsulation of the ferrous fumarate minimised the effect of temperature change.

Conclusions

Instant noodles made with iron-fortified flour have similar organoleptic properties to non-fortified noodles. This study estimates that instant noodles made with non-fortified flour and flour fortified with electrolytic iron, ferrous fumarate, and encapsulated ferrous fumarate have shelf lives of at least 12 months when stored at 30°C or less. The iron fortificant sodium iron EDTA, which was added in greater concentrations than recommended for wheat flour fortification in this study, had the greatest impact on appearance and flavour of the four fortificants tested.

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SINGAPORE POLYTECHNIC

Final Report on Accelerated Shelf Life Evaluation of Instant Noodles Made with Fortified Flour

(FIRC130153)

Prepared for

Flour Fortification Initiative

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1. Introduction

The objective of this project was to study the impact of iron fortified flour on the shelf life of instant noodles quantitatively over a determined period, by means of the following methods:

- Analyse the physical and chemical properties of the non-fortified and fortified products
- Evaluate the sensory attributes of the non-fortified and fortified products
- Estimate the shelf life of the products by adopting Accelerated Shelf Life Test model

2. Methodology

2.1 Production of instant noodle samples

The five variants of flour used are as below:

i. Non-fortified flour
ii. Flour fortified with EMCferro Elektrolytisch (Electrolytic iron)
iii. Flour fortified with EMCferro II-F (Ferrous fumarate)
iv. Flour fortified with EMCferro ll-F GF 50 (Encapsulated ferrous fumarate)
v. Flour fortified with EMCferro EDTA (Sodium iron EDTA)

The formulations of the five variants of noodles are shown in Table 2.
The manufacturers and suppliers for the ingredients are listed in Table 3.

The instant noodles were produced in accordance to the processing steps below:

a. Salt, guar gum, potassium carbonate, sodium carbonate, polyphosphates were mixed.
b. The gum mix were poured into water and set aside to hydrate for 30mins.
c. Iron functional ingredient was mixed in 100g of flour.
d. The iron mixture was then mixed into half the amount of the total flour for 1 min at slow speed using Hobart Legacy Mixer (HL200-2STD).
e. The balance flour was added into the mixture and continued mixing for 1 min at slow speed.
f. The gum solution was added in gradually and mixed for 1 min at slow speed.
g. Mixing speed was increased and continued mixing for 3 mins.
h. Noodle dough was set aside 15 mins for resting.
i. Dough went through sheeting process using noodle machine, HF Kejenteraan Sdn Bhd (HF03WN), until final thickness of 1.5mm.
j. Noodle dough was cut into noodle strands.
k. Noodle strands were steamed using Henny Penny Combimaster Electric Combi for 8mins.
l. Steamed noodles were portioned into 80g and inserted into noodle mould.
m. The noodles were fried using Frymaster (FPH-14/7) at 160°C for 8secs.
n. Fried noodles were cooled to ambient temperature and packed.
(Refer to Appendix 6.19 for packaging material specifications)

2.2 Accelerated Shelf Life Test (ASLT)

2.2.1 Instant noodle samples produced were stored under three types of storage conditions:

a. Low temperature storage for control samples which served as reference point
b. Commercial storage conditions
c. Elevated storage conditions to increase aging process

*Refer to Table 1 for the parameters of each storage condition

Table 1. Storage conditions for instant noodles for the purpose of ASLT

Storage condition	Temperature (°C)	Humidity (%)
Control/ Reference point	3-4	50-60
Commercial	25-28	75-80
Elevated	30	80
Elevated	35	80
Elevated	40	80

2.2.2 Samples were drawn out from the respective storage according to the planned test schedule with an assumption of temperature quotient, Q10, as 2. The Q10 value of a product is the temperature quotient for a 10°C temperature difference, as expressed in the equation below.

$$Q10 = \frac{Shelf - life\ at\ temperature\ T°C}{Shelf - life\ at\ T°C + 10°C}$$

A Q10 of 2 implies that the reaction doubles at 35˚C compared to that at 25˚C. Therefore, based on Q10 of 2, the shelf-life of 52 weeks at 25˚C is equivalent to approximately 34, 26 and 17 weeks at 30˚C, 35˚C and 40˚C storage conditions respectively. (Refer to Appendix 6.11 for the sampling schedule). The samples were equilibrated to ambient condition prior to chemical and physico-chemical analysis, elaborated in point 2.2.3 and 2.2.4. For sensory evaluation, samples were prepared based on the final serving conditions prior to serving to panellist, stated in point 2.2.5.

2.2.3 Chemical analysis

2.2.3.1 Iron content

Conducted by accredited laboratory, AsureQuality, using in-house method T6000, ICP-OES.

2.2.3.2 Peroxide value

Conducted by accredited laboratory, AsureQuality, using AOCS Cd 8-53 as reference method.

2.2.3.3 Free fatty acid

Conducted by accredited laboratory, AsureQuality, using AOCS Cd 5a-40 as reference method.

2.2.4 Physico-chemical analysis

Triplicates analysis was carried out each time for every sample.

2.2.4.1 pH

10% of grounded sample in deionised water was analysed using pH meter (Mettler Toledo Seven Easy).

2.2.4.2 Moisture content

Approximately 5g of grounded sample was analysed using moisture analyser (Mettler Toledo HR83-P-Halogen Moisture Analyser).

2.2.4.3 Colour

Grounded samples are analysed using spectrophotometer (Konica Minolta Spectrophotometer CM-5 Package/ Colorimeter).

Table 2. Formulations for five variants of instant noodles produced

Ingredients	Non-fortified		Elektrolytisch		II-F		II-F GF 50		Fe-EDTA	
	%	Weight (g)	%	Weight (g)	%	Weight (g)	%	Weight (g)	%	Weight (g)
Flour (Ikan Terbang Brand)	100	20000	100	20000	100	20000	100	20000	100	20000
Water	33	6600	33	6600	33	6600	33	6600	33	6600
Salt	1.5	300	1.5	300	1.5	300	1.5	300	1.5	300
Guar gum	0.2	40	0.2	40	0.2	40	0.2	40	0.2	40
Potassium carbonate	0.1	20	0.1	20	0.1	20	0.1	20	0.1	20
Sodium carbonate	0.1	20	0.1	20	0.1	20	0.1	20	0.1	20
Polyphosphates	0.1	20	0.1	20	0.1	20	0.1	20	0.1	20
EMCferro Elektrolytisch			0.006	1.20						
EMCferro II-F					0.019	3.76				
EMCferro II-F GF 50							0.043	8.58		
EMCferro EDTA									0.046	9.24
Total		**27000**		**27001.20**		**27003.76**		**27008.58**		**27009.24**

Table 3. Source of ingredients

Ingredient	Manufacturer	Local distributor	Specifications
Flour	Prima Limited	-	Refer to Appendix 6.1
Guar gum	Nature Colloids	-	Refer to Appendix 6.2
Potassium carbonate	Armand Products Company	Suntop Enterprise Pte Ltd	Refer to Appendix 6.3
Sodium carbonate	Sodawerk Stassfurt GmbH & Co.	Suntop Enterprise Pte Ltd	Refer to Appendix 6.4
Sodium tripolyphosphates, anhydrous	Innophos Inc.	Suntop Enterprise Pte Ltd	Refer to Appendix 6.5
Functional irons	Mühlenchemie GmbH & Co. KG	Stern Ingredients Asia Pacific	Refer to Appendix 6.6 – 6.9

2.2.5 Sensory evaluation

2.2.5.1 Preparation of instant noodles

a. Instant noodles were cooked in boiled water for a total of 3 mins.
b. At the 2nd minute, the noodles were being stirred for 1 min.
c. After cooking, the noodles are cooled down immediately in ambient temperature water for 30 secs.
d. The cooked noodles were then strained to drain away excess water.

2.2.5.2 Tasting of samples

a. Samples were served in tasting cups as a set at its intended serving temperature to panellist.
b. For each type of product, panellists were asked to taste the respective control sample (samples stored at 3-4°C, as stated in Table 1) prior to tasting each aged samples (samples stored under ambient and elevated conditions), and rate the differences according to the established attributes (appearance, flavour, texture) on a scale as depicted in Table 4. (See Appendix 6.10 for the sensory form template)
c. Panellists were requested to rinse their palate in between samples to reduce 'carry-over' effect.
d. To avoid fatigue, the panel compares a maximum of 4 samples for each set, given a rest time, before proceeding to the next set. Maximum of 5 sets per session.

Table 4. Sensory scale

Sensory Scale	Definition
0	Same as control
-1	Very slightly poorer than control
-2	Slightly poorer than control
-3	Moderately poorer than control
-4	Very much poorer than control
-5	Extremely poorer than control
-6	Unacceptable

3. Results and Discussion

For better representation of warehouse storage conditions in tropical countries, samples were stored under 30°C conditions and the results discussed in this section. For results of other storage conditions, refer to Appendix 6.12 to 6.18.

Noodles fortified with electrolytic iron will be known as Elektrolytish, ferrous fumarate as ll-F, encapsulated ferrous fumarate as ll-F GF50 and sodium iron EDTA as Fe-EDTA in this report.

3.1 Iron Content

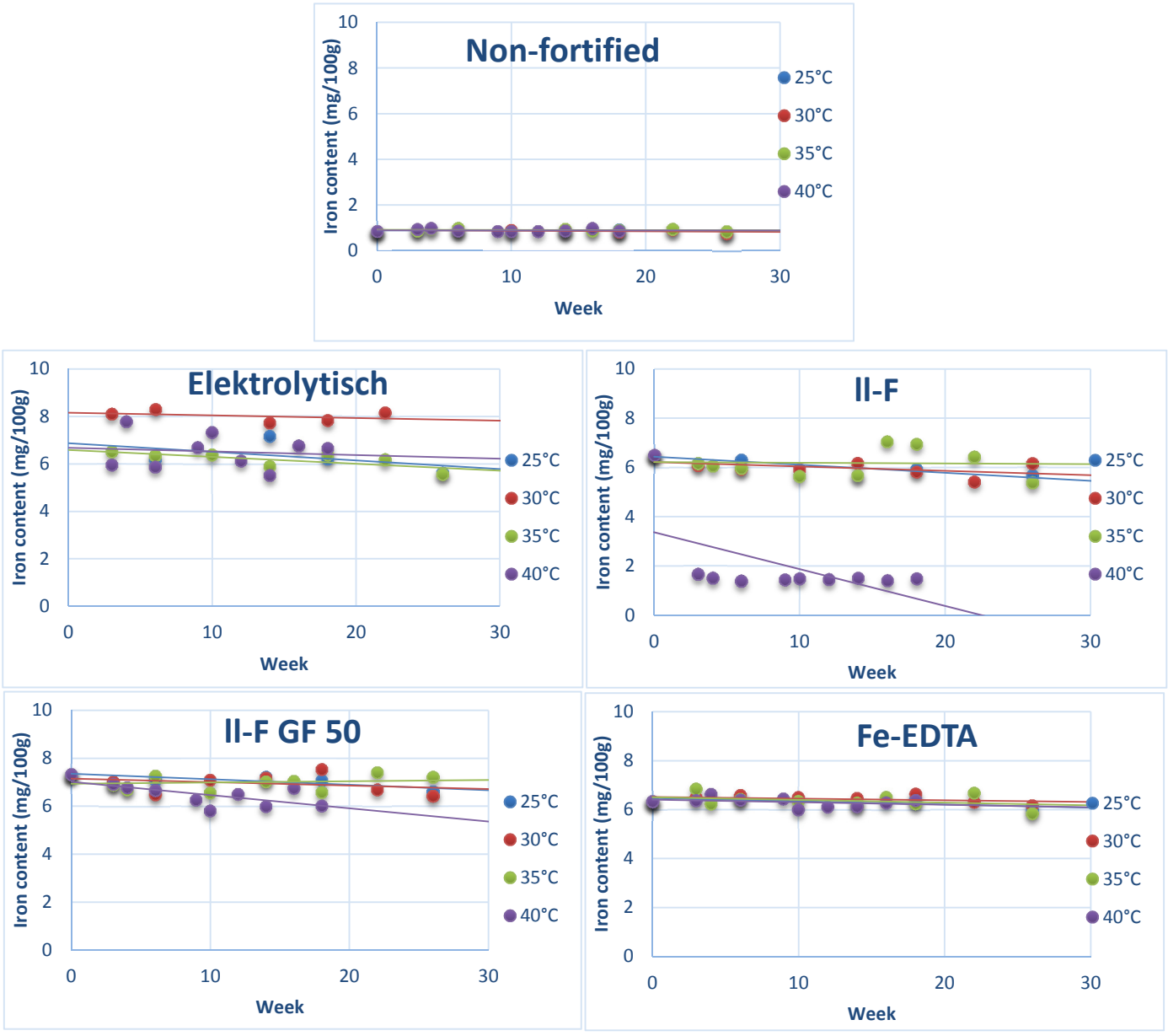


Figure 1. Iron content of instant noodle samples

The five types of instant noodle produced were sent for iron content analysis throughout the course of study. Apart from ll-F, the other types of fortification showed stable reading of iron content throughout the shelf life test period, albeit different storage temperatures. The fortification of different types of iron should yield a product with 6mg of iron content per 100g of product. For ll-F fortified samples, the samples stored under 40°C conditions displayed a reduction in the iron content which persisted throughout the shelf life study (Figure 1).

3.2 Peroxide value

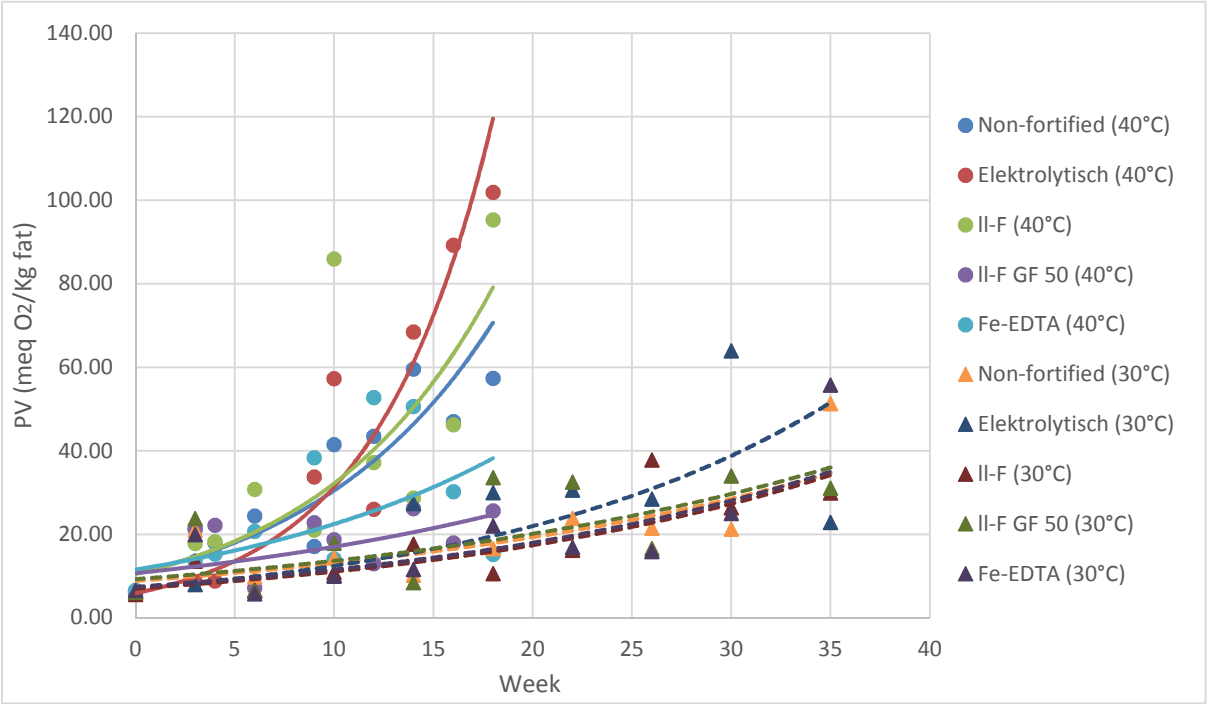


Figure 2.Peroxide values of instant noodle samples stored at 30°C and 40°C

Formation of hydroperoxide is a preliminary step in the oxidative rancidity of fats and oils (Shahidi and Wanasundara, 2008). Peroxides are known as the intermediate products of lipid oxidation which would eventually lead to the formation of volatile compounds responsible for rancid off flavours. From Figure 2, it is observed that, generally, peroxide value increased with increasing storage temperature. However, statistically, the change in iron fortified products are not significantly different from non-fortified samples for each storage temperature ($p>0.05$). This indicates that iron fortification has no effect on the initiation of oxidative rancidity process in instant noodles.

3.3 Free Fatty Acids

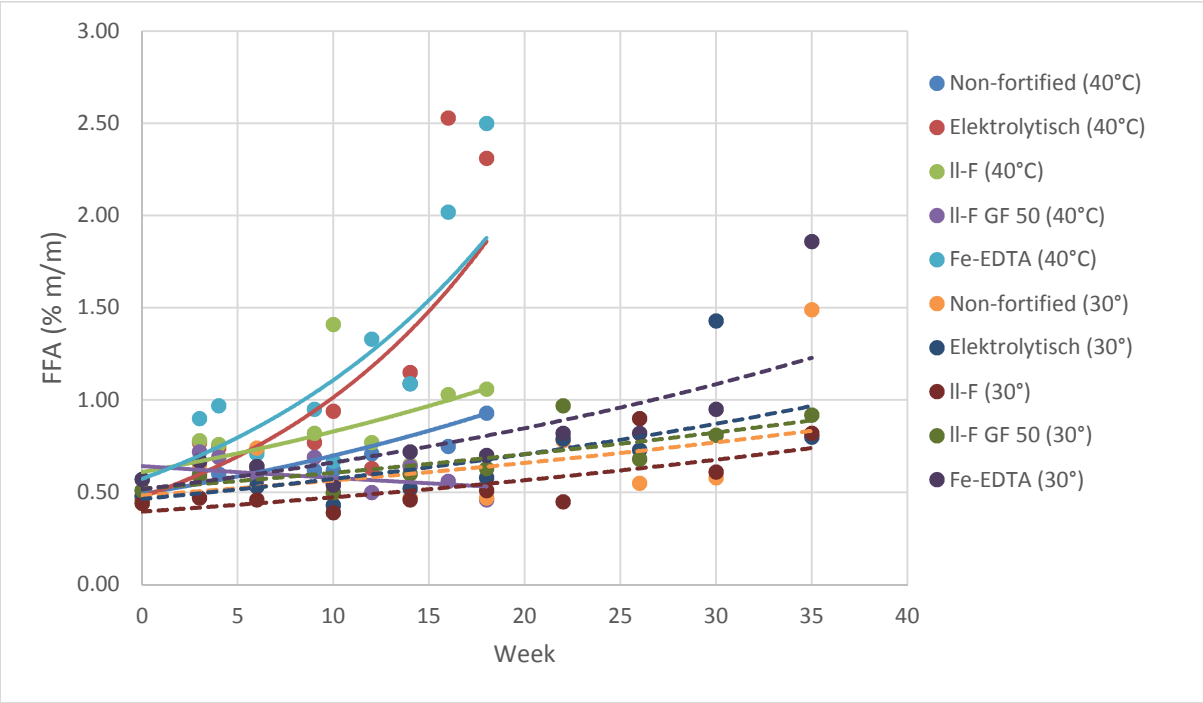


Figure 3. Free fatty acids amount for samples stored at 30°C and 40°C

Free fatty acids (FFA) are the products resulting from the hydrolysis of free fatty esters. Presence of FFA is associated with hydrolytic rancidity in food product, which may impart objectionable flavours to the product (O'Brien, 2008). From Figure 3, the trend is similar to peroxide value results, higher storage temperature was found to catalyse the hydrolysis reaction which resulted in higher amount of free fatty acids, with exception to ll-F GF fortified samples where the FFA values remained low throughout the storage at 40°C. Apart from temperature, trace metals may also accelerate the reaction, hence, the analyses served to understand the effect of different types of iron had on the rate of rancidity in instant noodles. From the results, only Elektrolytisch and Fe-EDTA fortified samples, stored at 40°C, have significant difference ($p<0.05$) as compared to non-fortified sample (Table 5). Noodles fortified with Fe-EDTA and Elektrolytisch, stored under 40°C conditions, showed an exponential increase in FFA values at the end of the shelf life test where the final FFA concentration was doubled the amount found in non-fortified samples. ll-F, ll-F GF50 and non-fortified samples, on the other hand, showed a more gradual increase over time. High FFA concentrations indicated rancidity in the products, which could be supported by sensory evaluation where the panel detected off flavours in the affected product.

3.4 Physiochemical analysis

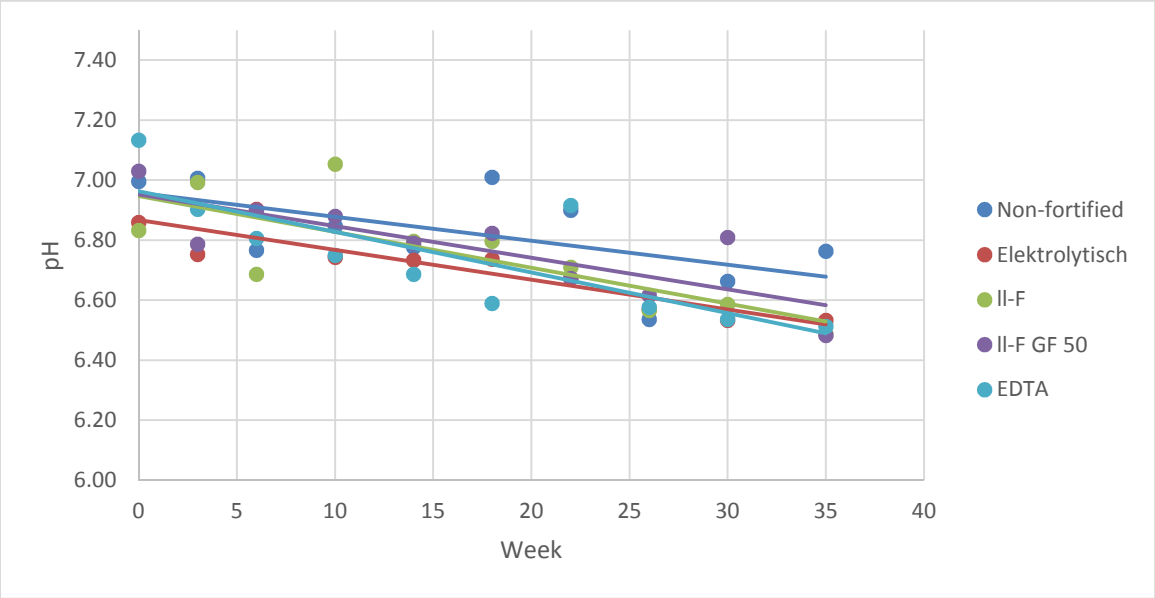


Figure 4. pH change in instant noodle samples stored at 30°C

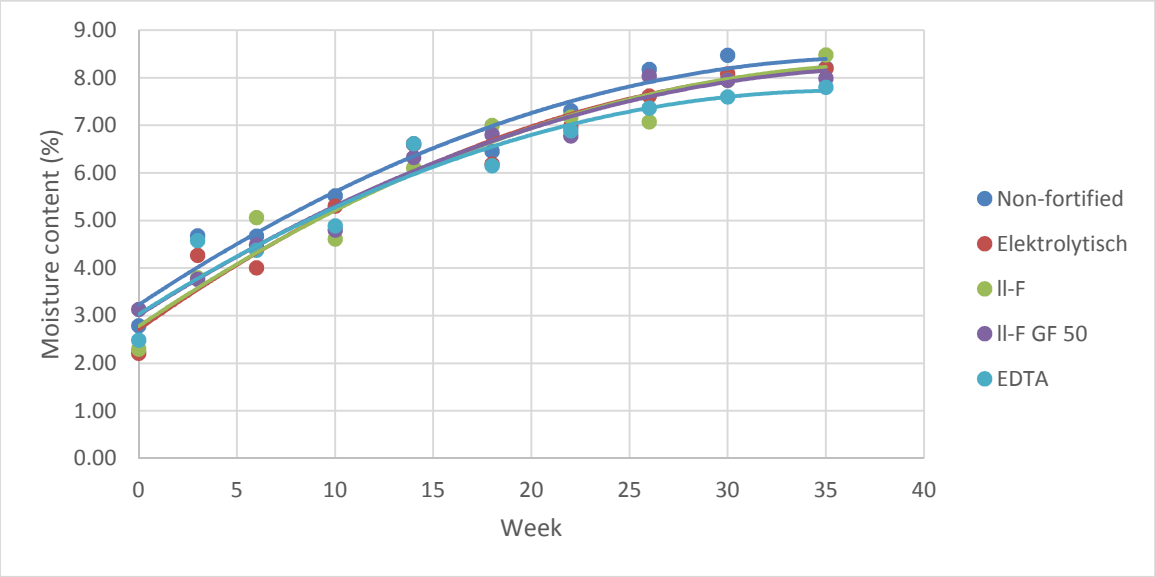


Figure 5. Moisture content of instant noodle samples stored at 30°C

The pH of all instant noodles showed a decreasing trend over time (Figure 4). This decrease was evident in both iron fortified and non-iron fortified products, which indicates that the incorporation of iron did not affect the pH value of the instant noodles (Table 5). Statistically, there is no significant difference between the non-fortified and iron-fortified samples ($p>0.05$)

Conversely, moisture content of all instant noodles, with or without iron fortifications, was found to increase over time (Figure 5). The increase in the moisture content of iron-fortified noodles were found to have no significant difference as compared to non-fortified noodles ($p>0.05$) (Table 5). For

this study, the standard packaging used was simulating what was commonly used in the instant noodle industry. This low barrier packaging material was the reason for the increase in moisture over time.

For appearance, the changes for each type of noodle over time were minimal. Using spectrophotometer to analyse the colour for the noodles, lightness (L) was found to have a visible difference, as shown in Figure 6. Generally, instant noodle fortified with Fe-EDTA was observed to be darker as compared to the other noodles, while non-fortified noodles had the lightest appearance. Statistically, Elektrolytish fortified samples stored under 30°C and Fe-EDTA fortified samples stored under 30°C and 40°C were found to be significantly darker than control ($p<0.05$), evidently shown in the L* values analysed (Figure 6). In terms of chromaticity a* and b*, there is no significant difference among the samples ($p>0.05$).

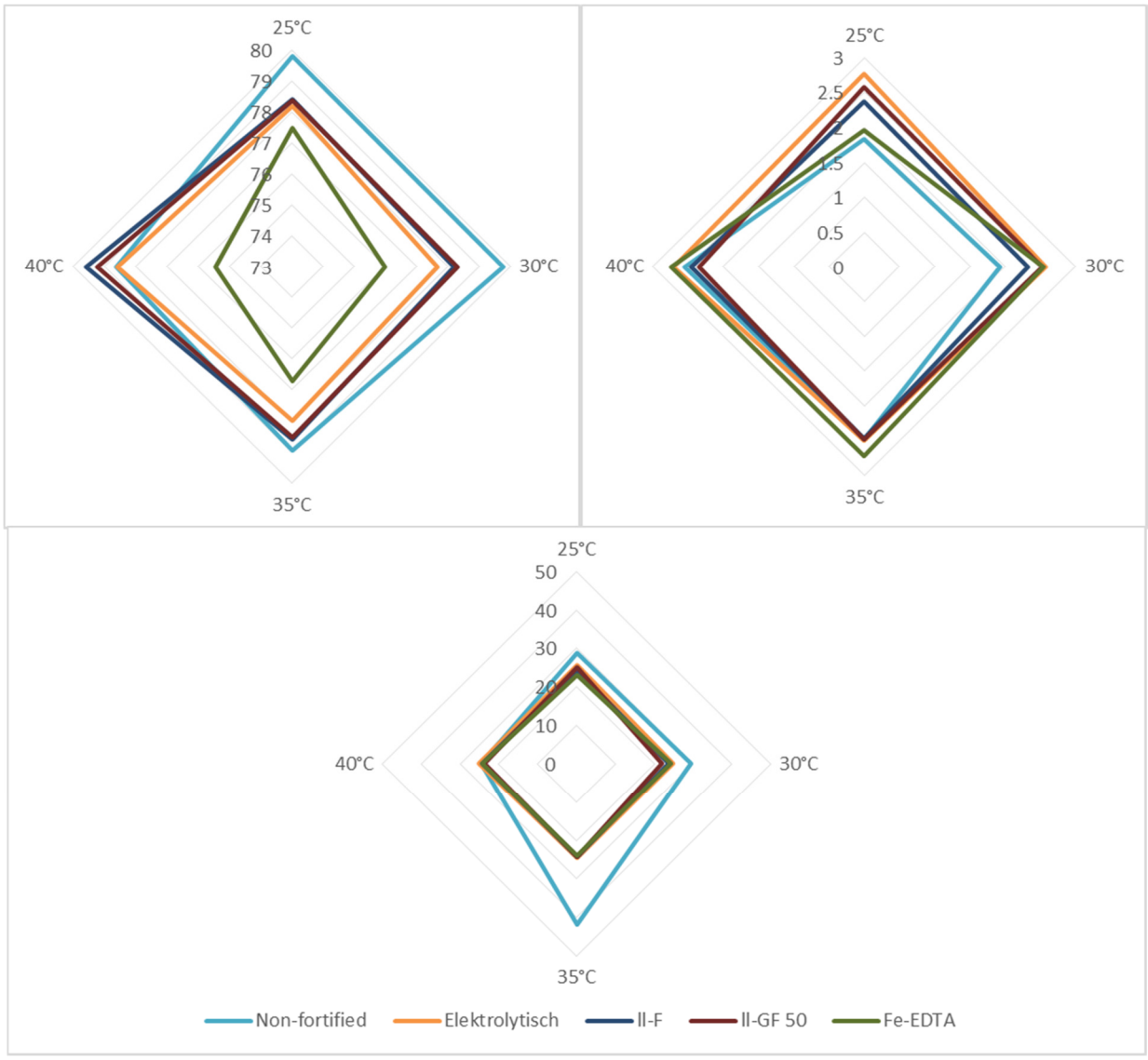


Figure 6. Average L (top left), a* (top right) and b* (bottom) values for instant noodle samples with respect to the different storage temperatures*

Table 5. Physical properties and chemical difference of iron fortified noodles vs non-iron fortified noodles

Test	40°C				35°C				30°C			
	Elek-	ll-F	ll-F GF50	Fe-EDTA	Elek	ll-F	ll-F GF50	Fe-EDTA	Elek	ll-F	ll-F GF50	Fe-EDTA
Chemical analysis												
Peroxide value	N	N	N	N	N	N	N	N	N	N	N	N
Free Fatty Acid	Y	N	N	Y	N	N	N	N	N	N	N	N
Physical properties analysis												
pH	N	N	N	N	N	N	N	N	N	N	N	N
Moisture content	N	N	N	N	N	N	N	N	N	N	N	N
Colour L*	N	N	N	Y	N	N	N	N	Y	N	N	Y
Colour a*	N	N	N	N	N	N	N	N	N	N	N	N
Colour b*	N	N	N	N	N	N	N	N	N	N	N	N

*Y signifies yes, there is a significant difference from the non-fortified noodles ($p<0.05$); N signifies no, there is no significant different from non-fortified noodles ($p>0.05$)

3.5 Sensory Evaluation

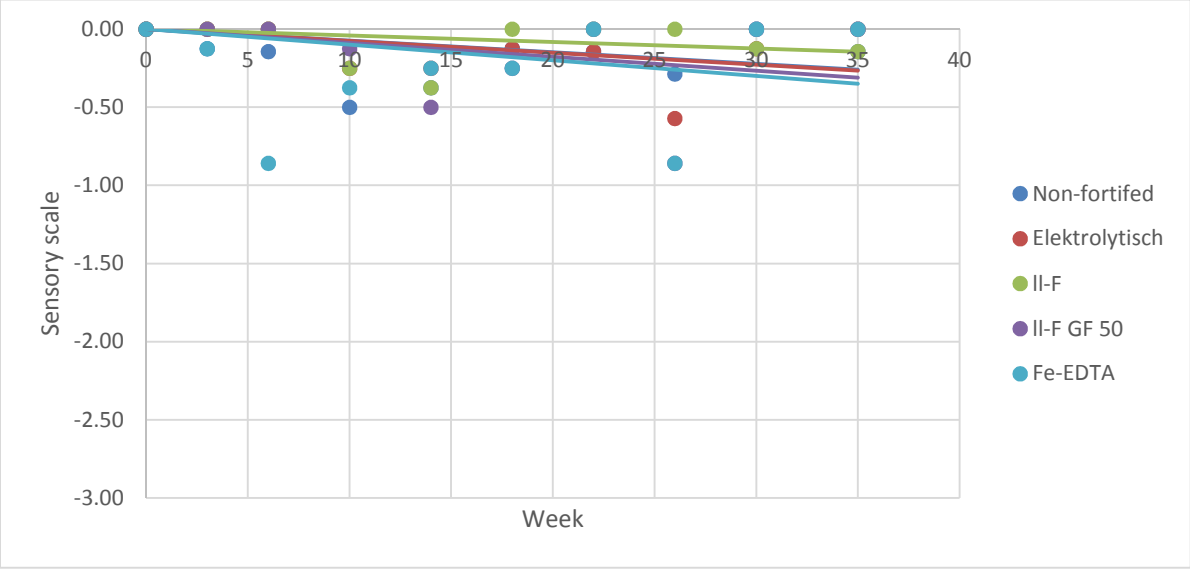


Figure 7. Sensory ratings of instant noodle samples stored at 30°C based on appearance attribute

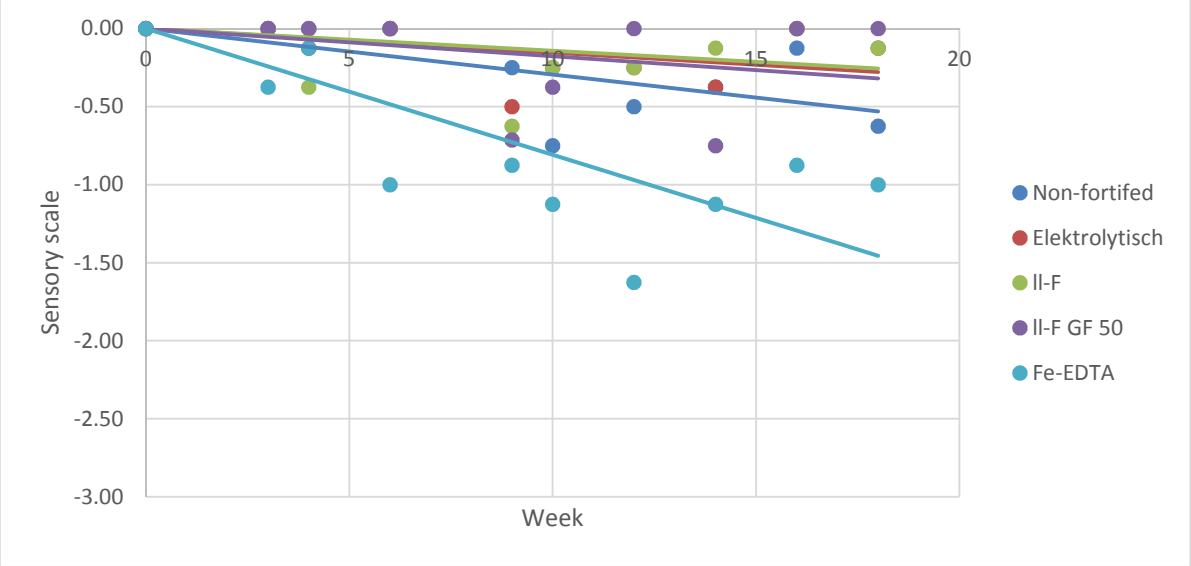


Figure 8. Sensory ratings of instant noodle samples stored at 40°C based on appearance attribute

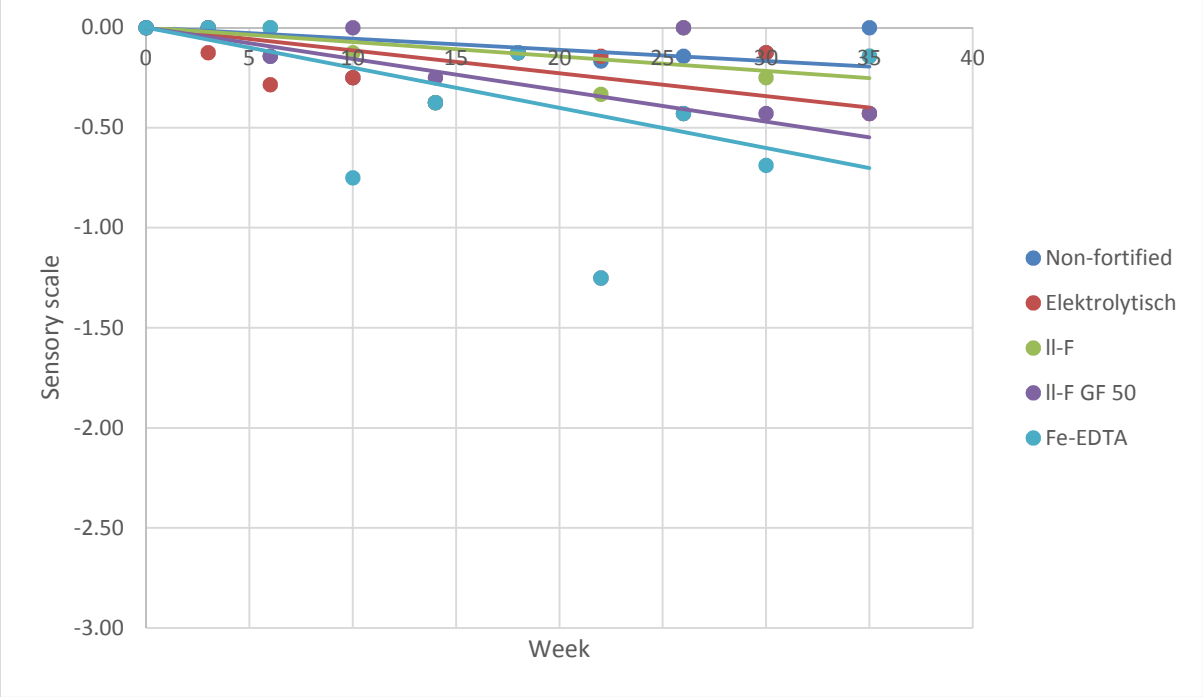


Figure 9. Sensory ratings of instant noodle samples stored at 30°C based on texture attribute

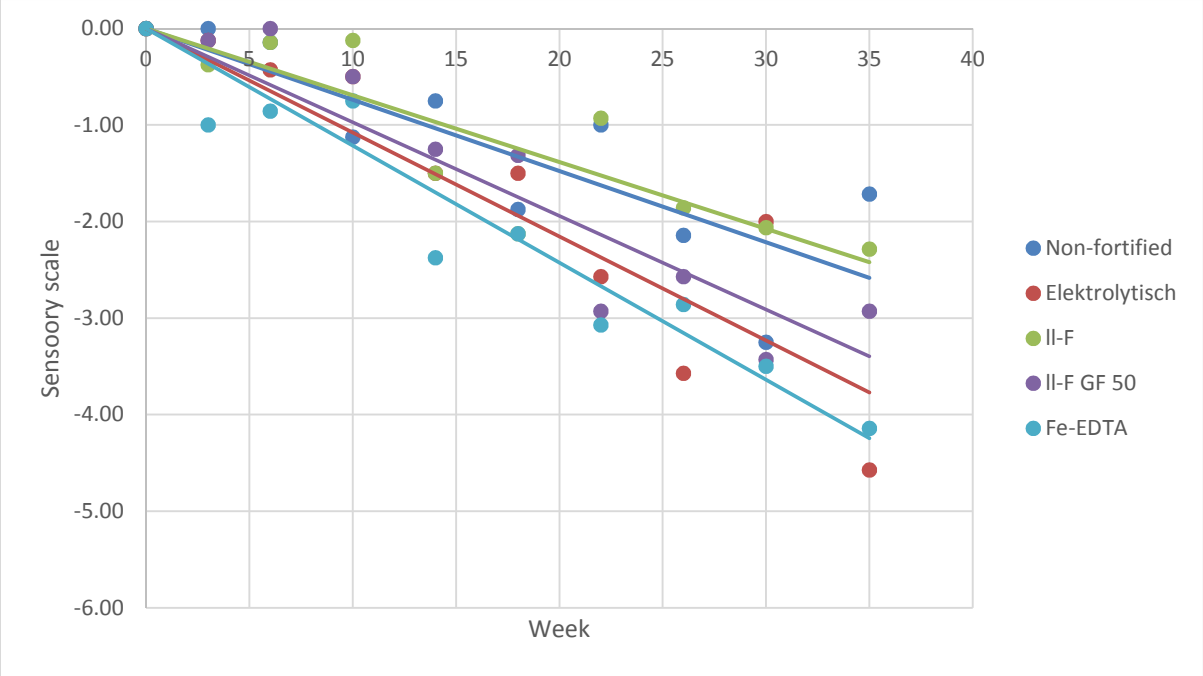


Figure 10. Sensory ratings of instant noodle samples stored at 30°C based on flavour attribute

Sensory evaluations were conducted on three attributes of the instant noodles, namely appearance, texture and flavour. In terms of appearance, the change over time was found to be minimal. As shown in Figures 7 and 8, with exception for Fe-EDTA fortified samples, the ratings given to each type of the noodles were between 0 and -1, which were interpreted as no difference from control and very slightly poorer than control (Table 4). For Fe-EDTA, the average ratings were between 0 and -2, which were interpreted as no difference from control to slightly poorer than control. In comparison to non-fortified noodles, the appearance of iron-fortified noodles was observed to have very slight difference except for Fe-EDTA samples stored under 40°C conditions, which was darker, as commented by panellists. This correlates to the objective colour measurement as discussed in earlier section where Fe-EDTA fortified noodles were also determined to be darker than the rest of the fortified noodles. FE-EDTA fortified samples are therefore more sensitive to heat as the change in lightness was more intense than the other type of fortification.

In terms of texture, the change over time was found to be minimal for both non-fortified and iron fortified samples. The worst rating given was -1.3, interpreted as slightly poorer than control, which is well within the acceptable range (Figure 9).

Figure 10 shows a decreasing trend in the sensory ratings for the flavour attribute of all products stored under 30°C conditions, which was noticed in all other storage temperatures as well (Appendix 6.18). Fe-EDTA fortified sample was found to have the steepest gradient, followed by Elektrolytisch fortified samples, indicating a faster rate of flavour deterioration. The reason for the deterioration was rancidity, which correlates to the free fatty acid analyses that were conducted and shown in Figure 3 where Fe-EDTA and Elektrolytisch fortified samples were found to have the highest amount of free fatty acids.

3.6 Shelf Life Analysis

Table 6. Shelf life estimation of five variants of instant noodle based on flavour attribute

Storage temperature (°C)	Estimated shelf life based on flavour (week)				
	Non-fortified	**Elektrolytisch**	**II-F**	**ll-F GF 50**	**Fe-EDTA**
25	133	97	168	93	88
30	80	60	86	58	51
35	48	37	43	37	29
40	28	22	22	23	17
Q_{10}	**2.78**	**2.63**	**3.83**	**2.51**	**2.95**

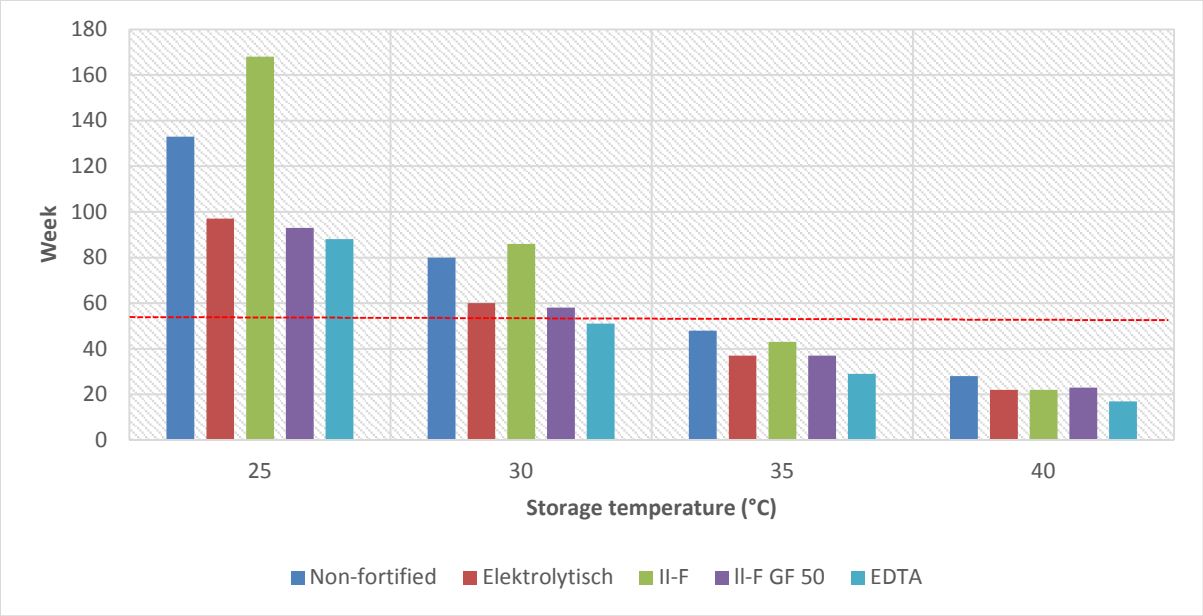


Figure 11. Estimated shelf life for non-fortified and iron fortified noodles at different storage temperatures. Red dotted line represents 1 year mark.

Accelerated shelf life test model (Robertson, 1999; Lee, Yam & Piergiovanni, 2008) was adopted to estimate the shelf life of each type of fortified instant noodles. The results were derived based on zero-order reaction prediction. Among the attributes tested in the sensory evaluation, flavour was found to have the highest impact in the acceptability of the products, proven by the steeper gradients (Figure 10) which signify a greater change over time. Therefore, flavour was established as the determining factor for the shelf-life of instant noodles in this study. Based on the analysis of results, the estimated shelf-life for each type of product under different storage conditions was listed in Table 6. Fe-EDTA fortified samples were found to have the shortest shelf-life in all storage conditions. This is consistent with the results discussed above where the rate of rancidity of Fe-EDTA was found to be the highest among all samples. In addition, the appearance was visibly darker than the other products, giving an overall negative appeal to the product.

The Q_{10} reaction of samples is derived by taking the shelf life ratio of two storage temperatures with 10°C difference. Ferrous fumarate fortified samples were found to have the highest Q_{10} value, signifying a greater change in flavour with every 10°C difference in storage conditions. On the other

hand, encapsulated ferrous fumarate samples were found to have the lowest Q_{10}, indicating a slower rate of change with temperature.

Depending on the warehouse temperature, the shelf life of the iron fortified noodles may vary due to the effect of heat and trace metal as catalysts. Generally, the shelf life of instant noodles shortened with higher storage temperatures as illustrated in Figure 11. Typically, for humid tropical countries where the temperature of warehouses is around 30°C, the instant noodles fortified with ferrous fumarate, encapsulated ferrous fumarate and electrolytic iron, were shown to be able to achieve one year shelf life, a common requirement set by manufacturers, based on the study conducted.

4. Conclusion

The effect of four types of iron fortification on the shelf-life of instant noodles were studied. It was found that Fe-EDTA fortified noodles have the shortest estimated shelf life. Main reason for the short shelf life is rancidity, causing off flavours in the product as time progresses. Although shelf life of noodles fortified with encapsulated ferrous fumarate and electrolytic iron were estimated to be shorter than non-fortified noodles, the shelf life may still meet the minimal requirement of food manufacturers, depending on the storage conditions the products would be subjected to.

Ferrous fumarate fortified product has the closest estimated shelf life compared to non-fortified noodles. An anomaly was observed in terms of the iron content of ferrous fumarate fortified samples stored at 40oC where the iron content was lower than that of samples stored at all other temperatures. It is postulated there may be some form of interaction of this iron fortification form when stored at 40oC. We recommend further studies to be carried out for a deeper understanding of the behaviour of this fortificant at elevated temperatures.

Accelerated shelf life studies conducted under controlled storage conditions may vary with actual real life scenario. Therefore, it is also recommended to validate the results with actual real-life production, distribution and storage conditions.

5. References

5.1 Shahidi, F. and Wanasundara, U. N. 2008. “Methods for Measuring Oxidative Rancidity in Fats and Oils” in *Food Lipids Chemistry, Nutrition, and Biotechnology, Third Edition*. C. C. Akoh, and D. B. Min, CRC Press, Chapter 14.

5.2 O’Brien, R.D. 2008. “Fats and Oils Analysis” in Fats and Oils Formulating and Processing for Applications, Third Edition. CRC Press, Capter 3.

5.3 Robertson, G. L. 1999. “Shelf Life of Packaged Foods, Its Measurement and Prediction” in Developing New Food Products For a Changing Marketplace. A. L. Brody and J. B. Lord, CRC Press, Chapter 13.

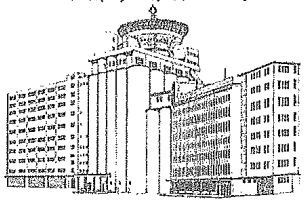
5.4 Lee, D.S., Yam, K.L., Piergiovanni, L. (2008). *Food Packaging Science and Technology*. Boca Raton, FL: CRC Press.

6. Appendix

6.1 Ingredient Specification- Flour

Prima Limited
201 Keppel Road
Singapore 099419
Tel (65) 6272 8811
Fax (65) 6273 2933 & 6273 5688
Website www.prima.com.sg
Reg. No. 196100049Z

百齡麥有限公司



QC /LPY/429/11/12

WHEAT FLOUR SPECIFICATION

Ikan Terbang Brand

Appearance		off white fine powder
Protein (N x 5.7)	(%)	10.5 - 11.5
Moisture	(%)	14.0 max.
Ash	(%)	0.55 max.
Wet gluten	(%)	28.5 min.
Shelf-Life		60 days

LIM PECH YUH
Deputy Manager (QA)
R&D Department

Revised 1

6.2 Ingredient Specification- Guar Gum

NATURAL COLLOIDS INDUSTRIES PTE LTD

Specification

Product : Guar Gum 200 (Supergel)

DESCRIPTION

A creamy white powder of a neutral smell and taste. Intended for use as a thickening and suspending agent in a variety of food applications, including beverages, mayonnaise, dressing, sauces, noodles, fish paste, fillings, creams and spreads etc.....

Component : **Guar Gum (Food Grade)** E-No. : E-412

It fully meets all specifications as outlined in the FAO/WHO and FCC and in the EEC directives.

CHARACTERISTICS

1) Moisture : < 15%

2) pH (1% solution) : 6.5 ~ 7.5

3) Viscosity : 5,000 cps min. after 24 hours.
(Brookfield RVT Viscometer with spindle No. #4, 20 rpm @ 1% soln. At exactly 25°C)

4) Protein (N x 6.25) : < 4.50%

5) Carbohydrate : 82.0% min.(by diff.)

6) A.I.R. : < 2.50%
(Acid Insoluble Residue)

7) Total Heavy Metals : < 20 ppm
Arsenic (As) : < 3 ppm
Lead (Pb) : < 2 ppm
Cadium (Cd) : < 1 ppm
Mecury (Hg) : NIL

8) Mesh size : 90% min. thru 200 US mesh.

9) Microbiological Test
Total Plate Count/g : 10,000/g max.
Yeast/Molds/g : 500 /g max.
E.Coli /1g : negative
Salmonella /25g : negative

PREPARATION OF SOLUTION

Slowly add the gum to the water using high speed mixer agitation. Do not allow the gum to lump by trying to disperse too quickly. If possible, premix the gum with other dry ingredients in the recipe.

Continue stirring until the dispersion and the solubilization are completed.

PACKING AND STORAGE

25 Kg net bag or 25 kg/fiber drum with 1-ply PE bag. Store away from heat and moisture, preferably at a temperature interior to 25°C (77°F) and at about 65% relative humidity.

The product can be stored for min. 12 months without change of quality when kept cool and dry place (unopened)

Date: 02-2013

40 Ubi Crescent, #01-08 Ubi Techpark, Singapore 408567
Tel: (65) 6743 2112 Fax: (65) 6743 1088
Website: http://www.natural-colloids.com
E.mail: sales@natural-colloids.com

Cert No. : 160 105

6.3 Ingredient Specification- Potassium Carbonate

東昇有限公司

ARMAND PRODUCTS COMPANY

Armand Products Company
469 North Harrison Street • Princeton, NJ 08543-5297
Phone (800) 522-0540 • Fax (800) 335-8861
Technical Service
Phone (716) 278-7071 • Fax (716) 278-7297

POTASSIUM CARBONATE
DENSE REGULAR ANHYDROUS

SALES SPECIFICATION

Component	Basis	Specification[1]
Total Alkalinity (as K_2CO_3)	wt. %	99.5 Min.
KOH	wt. %	0.20 Max.
KCl	wt. %	0.01 Max.
H_2O	wt. %	0.5 Max.
Na	wt. %	0.38 Max.
K_2SO_4	ppm by wt.	75 Max.
As	ppm by wt.	3.0 Max.
Fe	ppm by wt.	2.0 Max.
Heavy Metals (as Pb)	ppm by wt.	5.0 Max.
Hg	ppm by wt.	0.05 Max.
Ni	ppm by wt.	1.0 Max.

Particle Size Distribution (not a specification item)	Typical Range
	-18 mesh to + 80 mesh

Notes:
[1] Meets Food Chemical Codex (FCC) and The United States Pharmacopeia/The National Formulary (USP/NF) specifications.

SUNTOP ENTERPRISE PTE. LTD.

6.4 Ingredient Specification- Sodium Carbonate

SODA

Product Data Sheet

SODA ASH LIGHT
(SODIUM CARBONATE)

Appearance	white pulverulent
Molecular weight	105,99
Chemical formula	$Na2CO_3$

Chemical Analysis:

		Guarantee Figures	Typical values
Na_2CO_3	%	Min. 99,2	99,2-99,7
NaCl	%	Max. 0,20	0,1-0,2
Fe_2O_3	%		0,001-0,0025
Heavy metals (Pb)	%		0,0-0,001
CaO	%		0,005-0,008
MgO	%		0,0005-0,001
Water insolubles	%		0,001-0,01
pH (20°C) at 100g/l H_2O			11,6
Bulk density g/ml		Min. 0,520	0,55-0,62

Grain size distribution %

>1,000	mm	Max. 4	0,0-0,5
<0,056	mm		20-35

Storage & stability	To be stored indoors in moisture-proof packing in dry & cool rooms. Shelf life: 2 years in unopened bags	
Applications	Glass industry Detergents Water glass	Chemicals Water purification Flue gas desulphurisation

SUNTOP ENTERPRISE PTE LTD

6.5 Ingredient Specification- Sodium Tripolyphosphate

東昇有限公司

Product Information

SODIUM TRIPOLYPHOSPHATE, ANHYDROUS

Powder and Granular Grades
Food Chemicals Codex

DESCRIPTION
Sodium Tripolyphosphate, Anhydrous is a white granular or powder material which complies with the specifications of the Food Chemical Codex and the American Water Works Association Standard B-503-01.

FORMULA
$Na_5P_3O_{10}$

CAS NUMBER
7758-29-4

CAS INDEX NAME
Triphosphoric Acid, Pentasodium Salt

E NUMBER
451i

GRADES
Standard FCC Granular – code 20G
Moderate Phase I, FCC Granular - code 76P
Standard FCC Powder - code 20A
Moderate Phase I, FCC Powder – code 76S

STORAGE
Cool and dry

MINIMUM ORDER
One Pallet

SPECIFICATIONS

Assay (as $Na_5P_3O_{10}$ dry basis)	85.0% minimum
Arsenic (As)	3 ppm maximum
Fluoride (F)	50 ppm maximum
Lead (Pb)	2 ppm maximum
Water Insolubles	0.1% maximum

USES
A wide variety of processed food products including dairy and meat processing.
Water Treatment
Sequestrant for alkaline metals, scale control, corrosion control, softening, lead control, red and black water control.

CERTIFICATES
Includes Kosher, NAFTA, HALAL and others.

SHELF LIFE
18 Months

LABEL DECLARATION
Sodium Tripolyphosphate

MANUFACTURING LOCATION(S)
Port Maitland, ON

SHIPPING POINT(S)
Port Maitland, ON
Chicago Heights, IL
Toronto, ON

CONTAINERS
50-pound net weight Paper Bags, 40 per pallet
Other containers may be available upon request.

TYPICAL PROPERTIES

pH (1% solution)	9.9	
Solubility (grams per 100 grams at 25° C)	15	
Sieving	Granular	Powder
through 20 mesh	> 90%	> 99%
through 100 mesh	<35%	>90%
Bulk density, g/cc (loose)	0.6	0.8

03/07

SUNTOP ENTERPRISE PTE. LTD.
No. 73 Tuas View Loop Singapore 637713

GST Reg. No. M2-8922500-5

6.6 Ingredient Specification- Emceferro Electrolytic

Mühlenchemie
makes good flours even better

Product specification

Product name	**Emceferro Electrolytic**
Article no.	10M5007
Description	Iron powder, electrolytic Corresponds to FCC V Function: Nutrient
Ingredients	Electrolytic iron
Storage & shelf-life	Min. 18 months if stored cool and dry in closed original packing
Packaging	Cardboard box or multiply paper bag with PE-Inliner, 25 kg net

Chemical, physical & microbiological properties

Property	Method	Dimension	Target	Min - Max
Appearance			gray-black, fine powder	
Content of reduced iron		g/100 g	> 97	
Identity			passes test	
Acid unsoluble		g/100 g	< 0.2	
Lead		mg/kg	< 4	
Arsenic		mg/kg	< 3	
Mercury		mg/kg	< 2	
Granulation	Sieve Analysis of Granular Metal Powders			
through 100 mesh		g/100 g	100 %	
through 325 mesh		g/100 g	> 95%	

n.d. = not determined

Mühlenchemie GmbH & Co. KG
Kurt-Fischer-Straße 55
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info@muehlenchemie.de
www.muehlenchemie.de

Version 18.01.2013 Print 26.06.2013

STERNWYWIOL Gruppe

6.7 Ingredient Specification- Emceferro II-F

Mühlenchemie
makes good flours even better

Product specification

Product name	**EMCEferro II-F**
Article no.	10M5009
Description	Ferrous fumarate Corresponding to BP
Ingredients	Iron-II-fumarate
Storage & shelf-life	Min. 18 months if stored cool and dry in closed original packing
Packaging	Cardboard box or multiply paper bag with pe-Inliner, 25 kg net

Chemical, physical & microbiological properties

Property	Method	Dimension	Target	Min - Max
Appearance	sensorial	g/100 g	fine red to brownish powder	
Iron content	ICP/OES	g/100 g	32	
Content of ferrous fumarate	calculated on dry basis	g/100 g	> 93	93 - 101
Fe^{3+} content	ICP/OES	g/100 g	< 2	
Loss on drying	3 h, 105°C	g/100 g	< 1	
Sulphate	gravimetric	g/100 g	< 0.2	
Heavy metals (as Pb)	ICP/OES	mg/kg	< 10	
As	ICP/OES	mg/kg	< 3	
Lead	AAS	mg/kg	< 2	
Mercury	AAS	mg/kg	< 3	
Total plate count		cfu/g	< 50.000	
Enterobacteriaceae		cfu/g	< 1.000	
E.coli		cfu/g	neg.	
Salmonellae		/ 25 g	neg.	

n.d. = not determined

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Version 26.03.2007 Print 26.06.2013

STERN WYWIOL Gruppe

6.8 Ingredient Specification- Emceferro II-F GF50

Mühlenchemie
makes good flours even better

Product specification

Product name	**Ferrous Fumarate, encapsulated**
Article no.	10M5044
Description	Conform to current FCC monograph
Ingredients	Fe (II) (16%), microencapsulated with 50% palm oil
Storage & shelf-life	Min. 18 months if stored cool and dry in closed original packing
Packaging	on request

Chemical, physical & microbiological properties

Property	Method	Dimension	Target	Min - Max
Appearance		g/100 g	red to brownish granules	
Content of iron		g/100 g		14 - 17
Identification	FCC		Complies	
Fe^{3+} content		g/100 g	< 2	
Sulphate		g/100 g	< 0.2	
Lead		g/100 g	< 0.001	
Mercury		g/100 g	< 0.0003	

n.d. = not determined

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Version 14.05.2013 Print 26.06.2013

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6.9 Ingredient Specification- Emceferro EDTA

Mühlenchemie
makes good flours even better

Product specification

Product name	**EMCEferro EDTA**
Article no.	10M5043
Description	Sodium Iron (III) EDTA High bioavailable iron for food fortification.
Ingredients	Sodium iron-III-ethylenediaminetatraacetate The product is GRAS and meets the requirements of JECFA and FCC.
Storage & shelf-life	Min. 18 months if stored cool and dry in closed original packing
Packaging	Cardboard box or multiply paper bag with PE-Inliner, 25 kg net

Chemical, physical & microbiological properties

Property	Method	Dimension	Target	Min - Max
Appearance			yellowish powder	
Iron		g/100 g		12,5 - 13,5
Bulk density		kg/L	0.57	
Water insoluble matter		g/100 g	< 0.1	
pH value	1% w/v aqueous solution	g/100 g		4,5 - 5,5
Lead (Pb)		mg/kg	< 1	
Arsenic (As)		mg/kg	< 1	

n.d. = not determined

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Version 23.05.2012 Print 26.06.2013

STERNWYWIOL Gruppe

6.10 Sensory Evaluation Form Template

Sensory evaluation of fried instant noodle

Date: _____

Please taste the control and the samples. Rate the difference of each sample as compared to control according to the attributes listed using the 7-point scale as defined below. Kindly rinse your palate with water in between samples.

SENSORY SCALE	DEFINITION
0	Same as control
-1	Very slightly poorer than control
-2	Slightly poorer than control
-3	Moderately poorer than control
-4	Very much poorer than control
-5	Extremely poorer than control
-6	Unacceptable

Sample code: _____

Appearance

☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

Texture

☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

Flavour

☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

Other Comments: _____

Sample code: _____

Appearance

☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

Texture

☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

Flavour

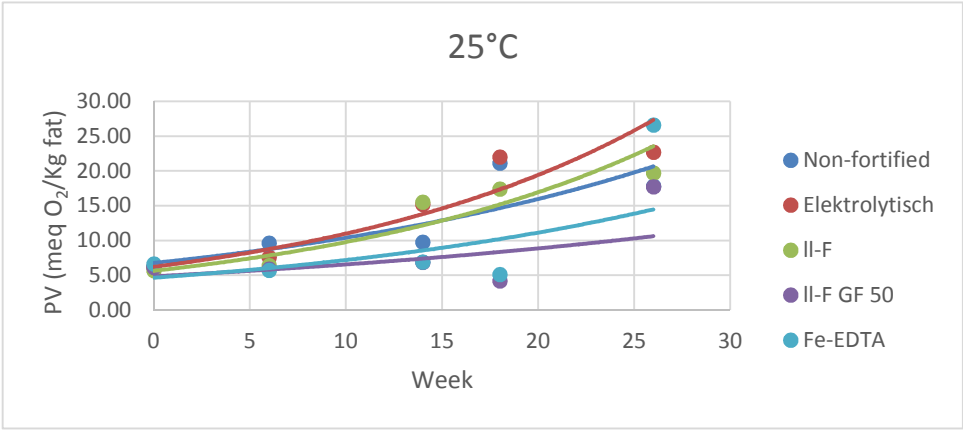
☐ 0 ☐ -1 ☐ -2 ☐ -3 ☐ -4 ☐ -5 ☐ -6

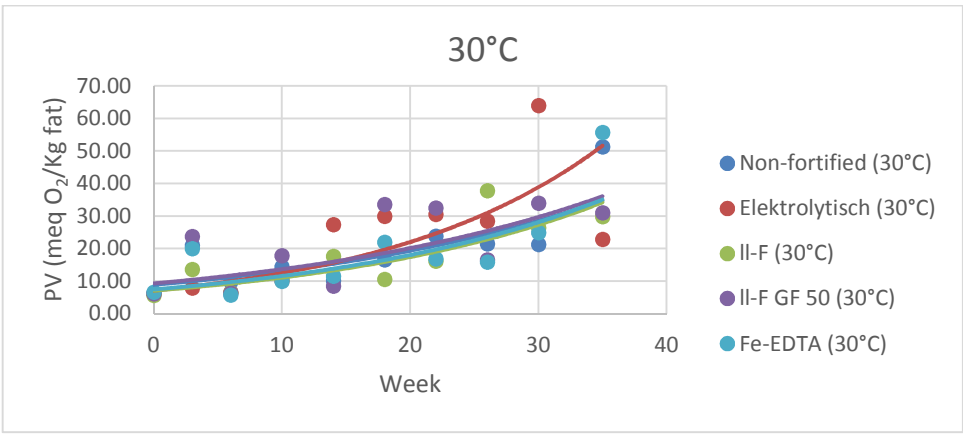
Other Comments: _____

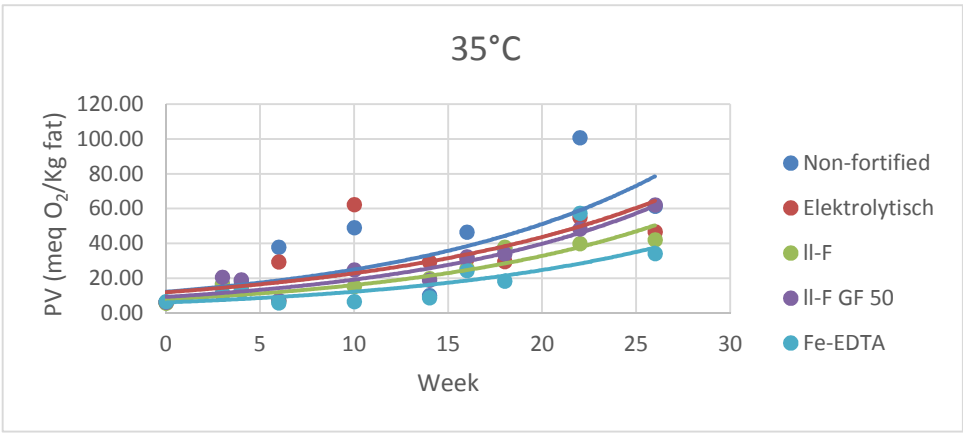
6.11 Sampling Schedule for Physio-chemical Analysis and Sensory Evaluation

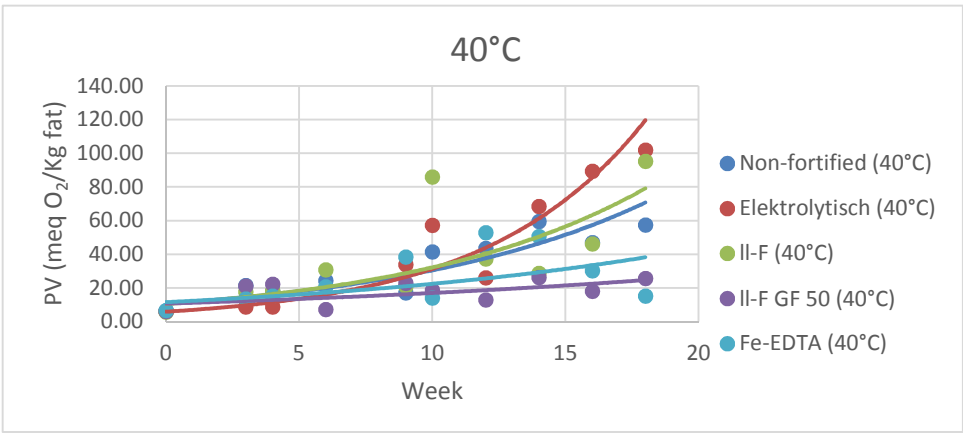
Storage temperature (°C)	Week																	
	0	3	4	6	9	10	12	14	16	18	22	24	26	30	35	42	49	52
40		√	√	√	√	√	√	√	√	√								
35		√	√	√		√		√	√	√	√	√	√					
30		√		√		√		√		√	√		√	√	√			
25				√				√		√			√	√	√	√	√	√
3-4	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√

6.12 Graphs for Peroxide Values Analyses (grouped according to storage conditions)

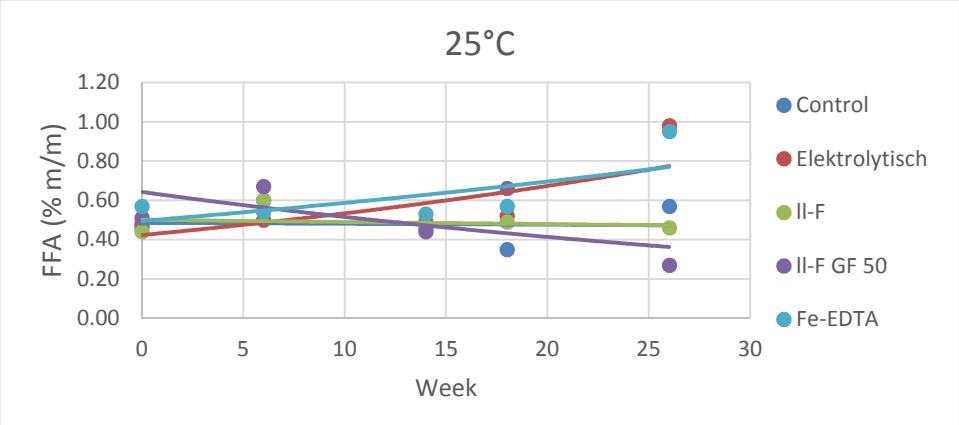


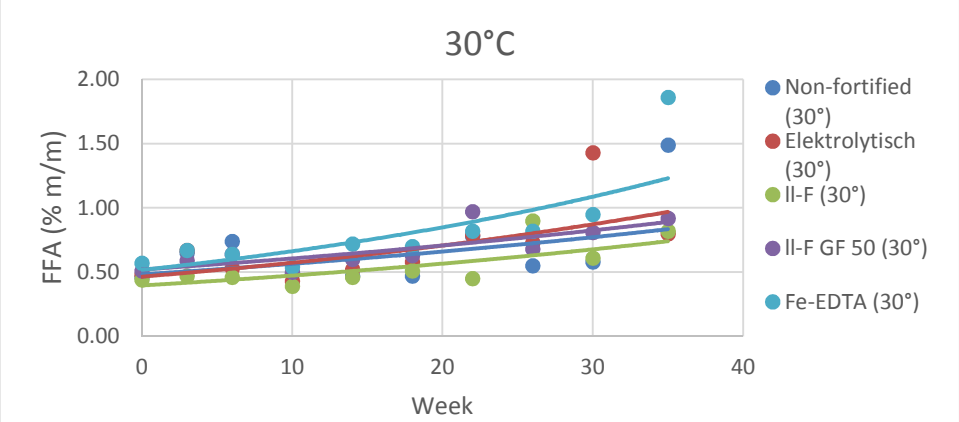


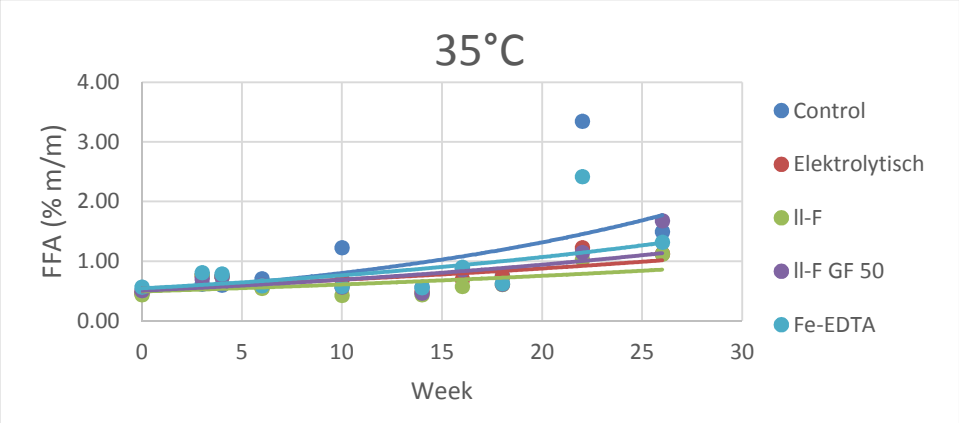


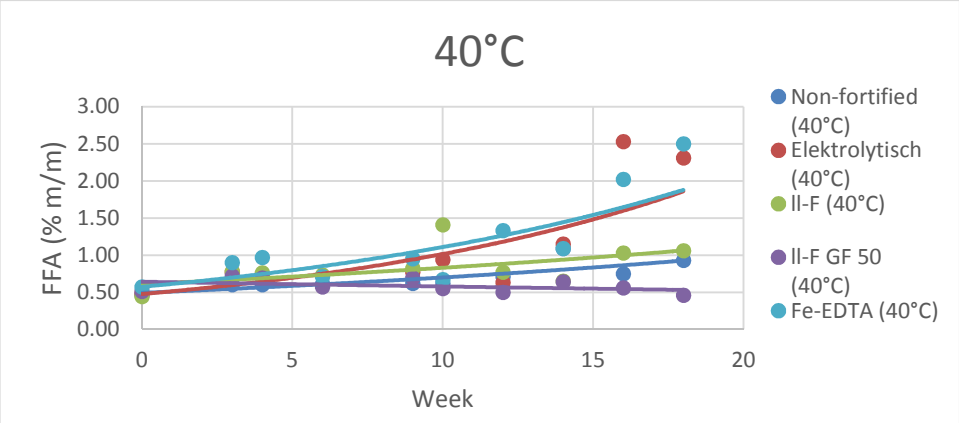


6.13 Graphs for Free Fatty Acids Analyses (grouped according to storage conditions)

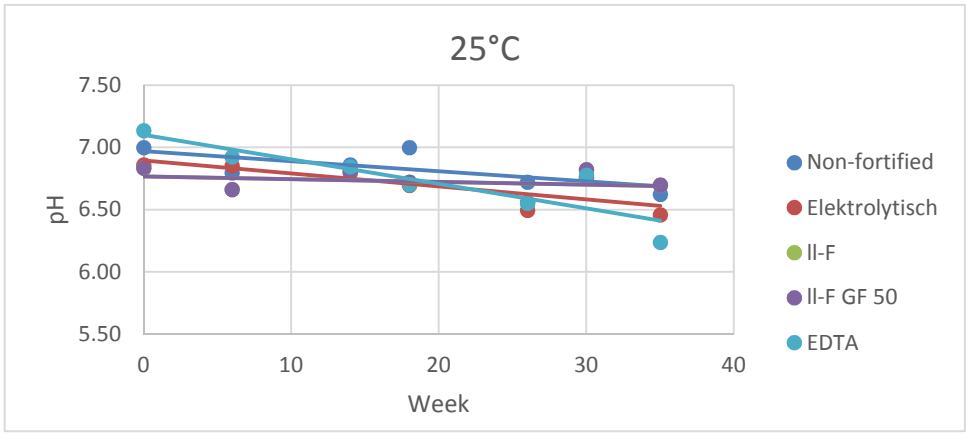


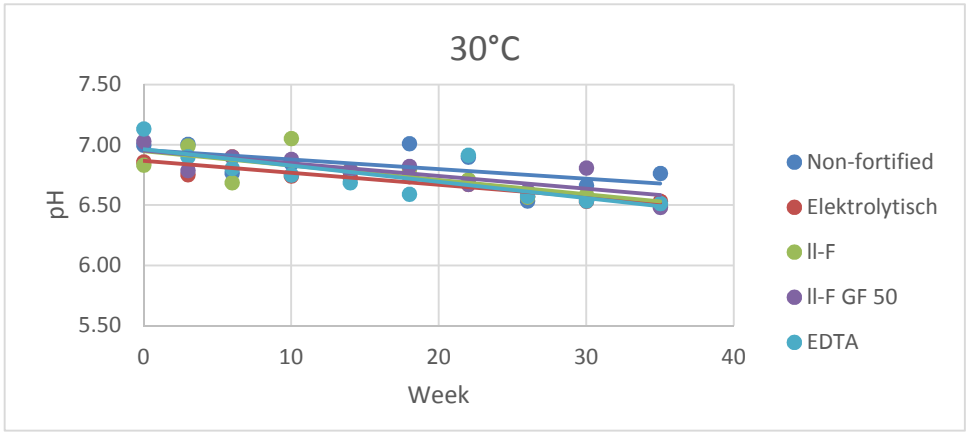


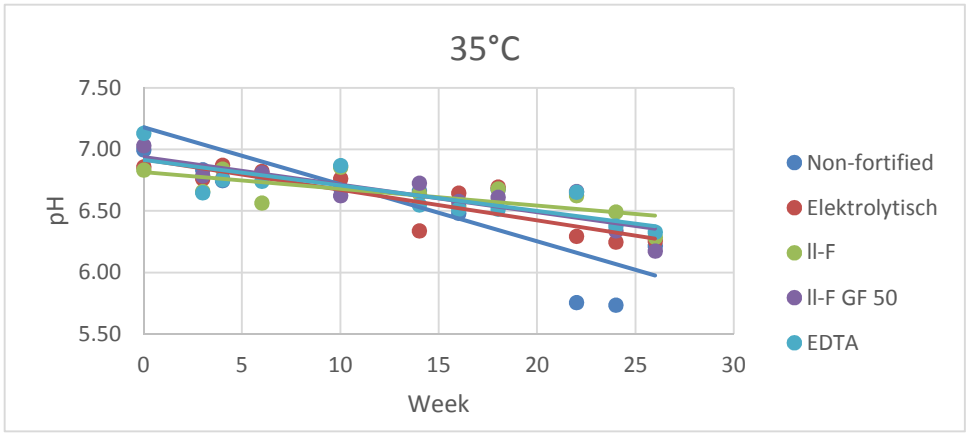


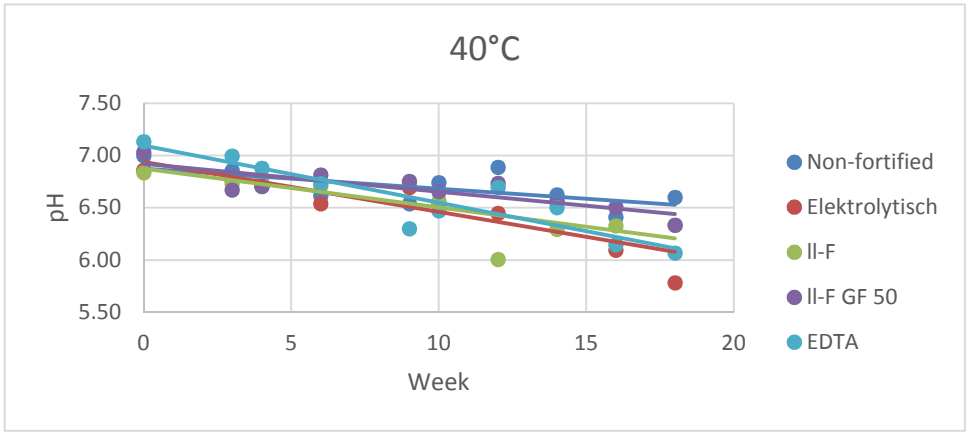


6.14 Graphs for pH Analyses (grouped according to storage conditions)

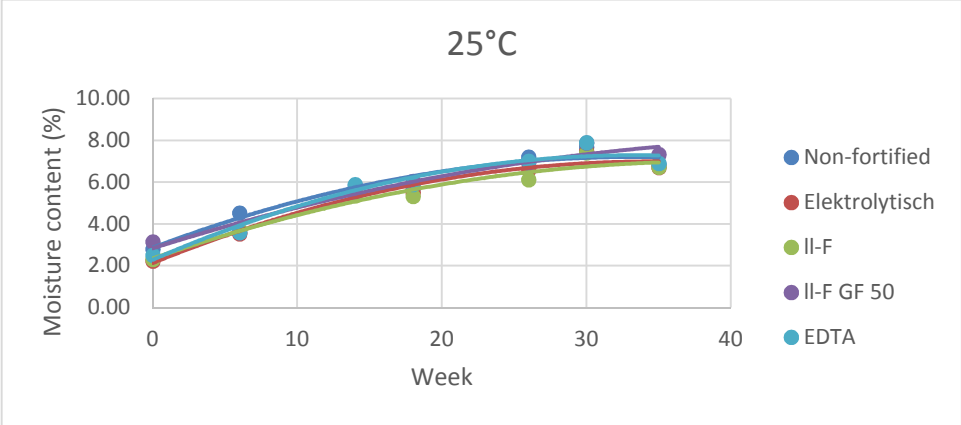


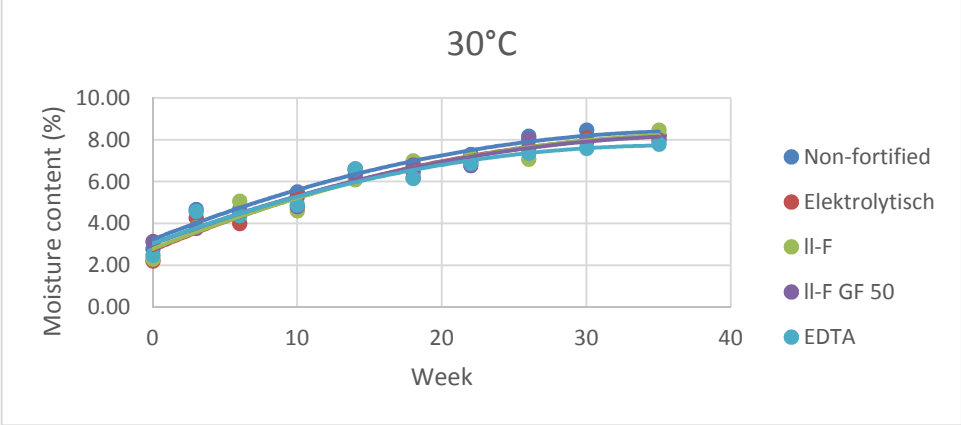


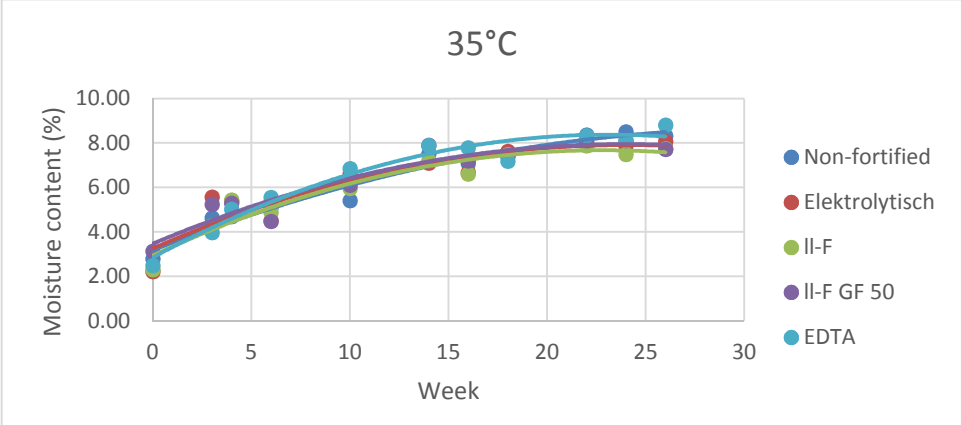


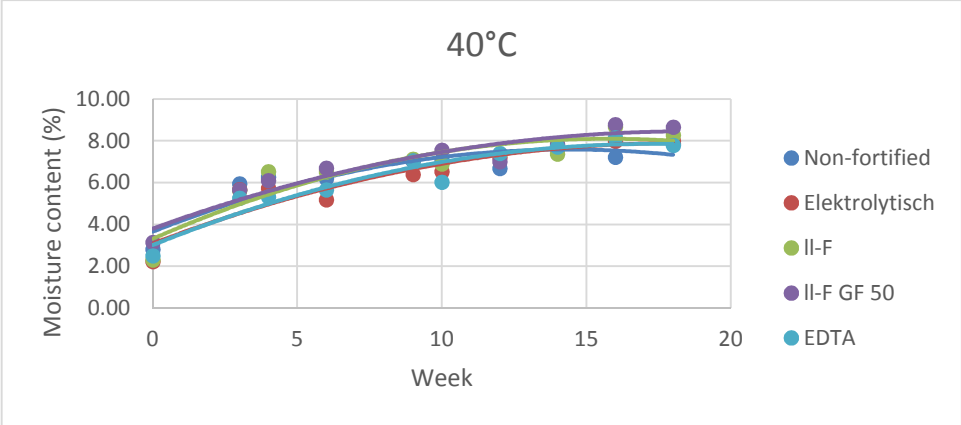


6.15 Graphs for Moisture Content Analyses (grouped according to storage conditions)

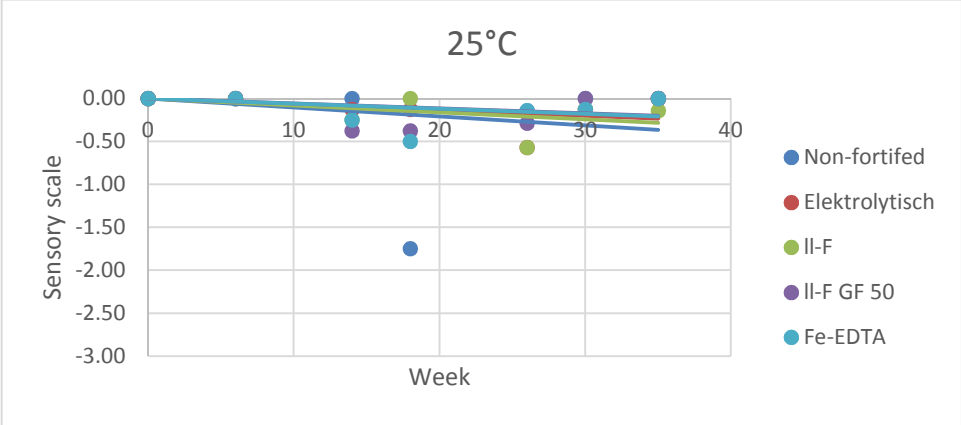


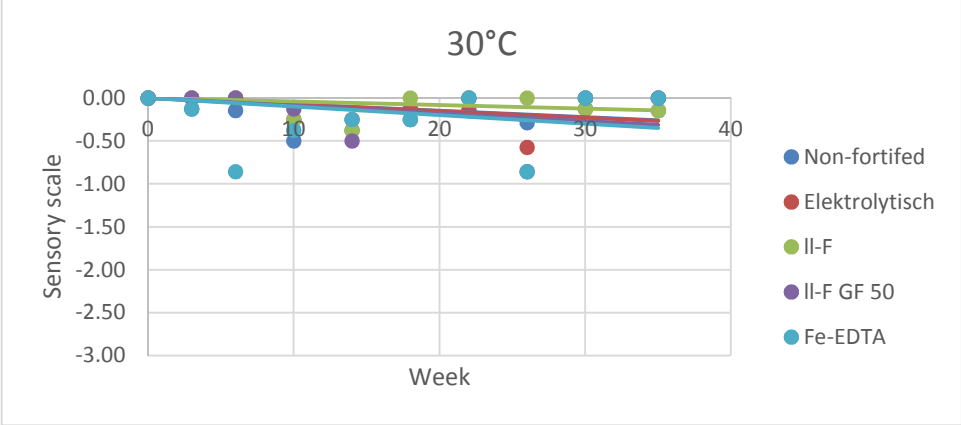


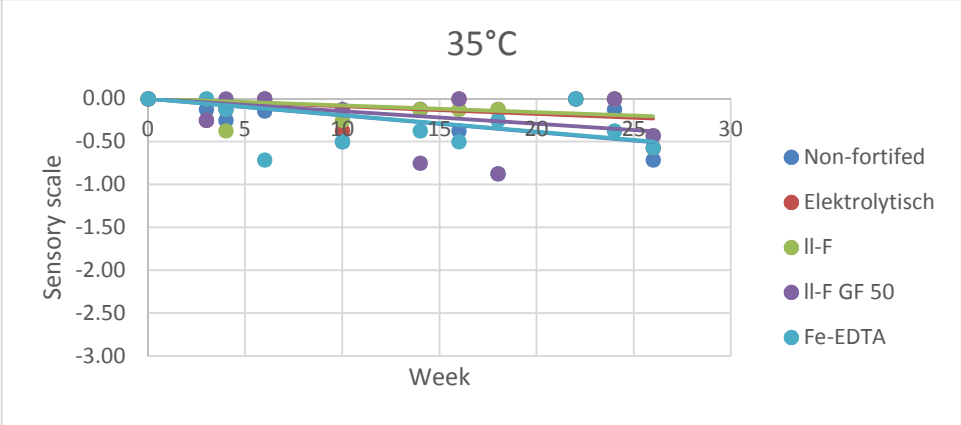


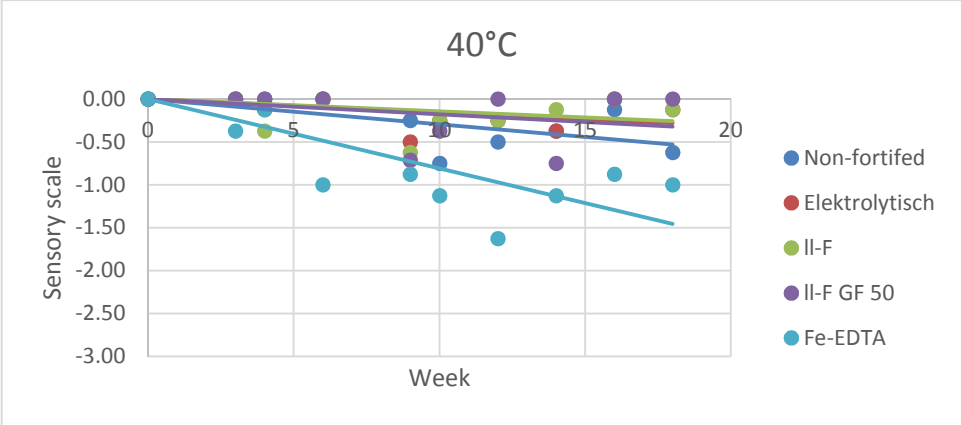


6.16 Graphs for Sensory Evaluation Appearance Attribute (grouped according to storage conditions)

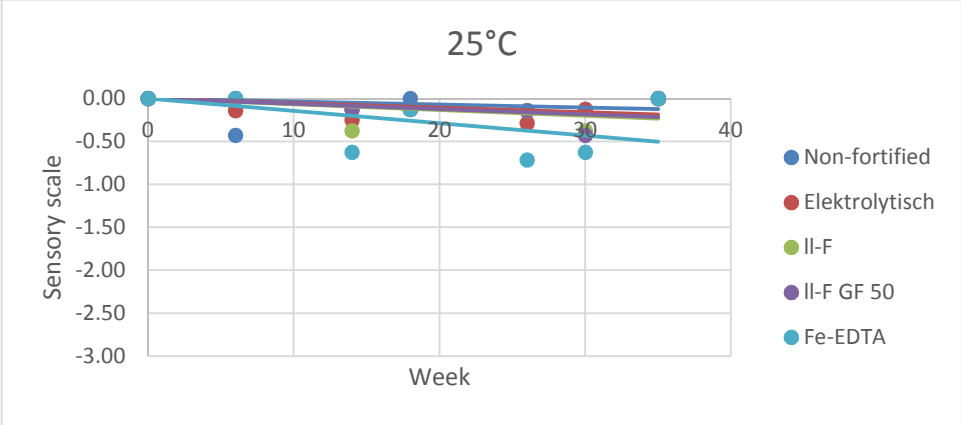


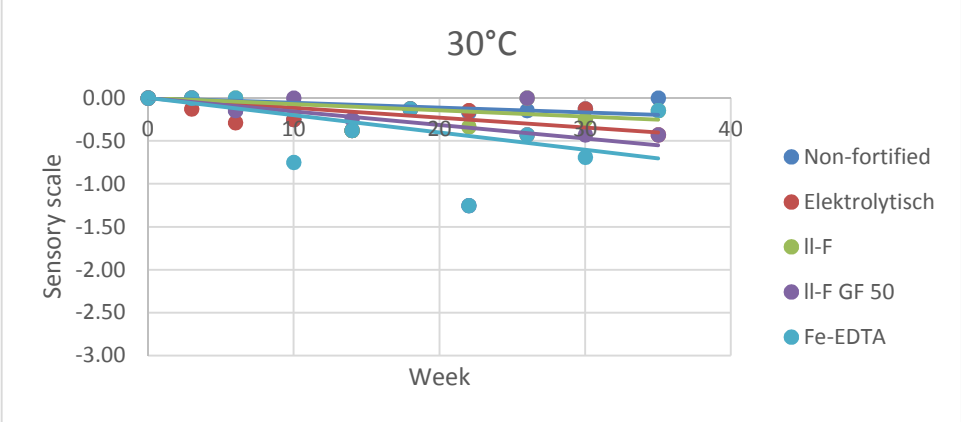


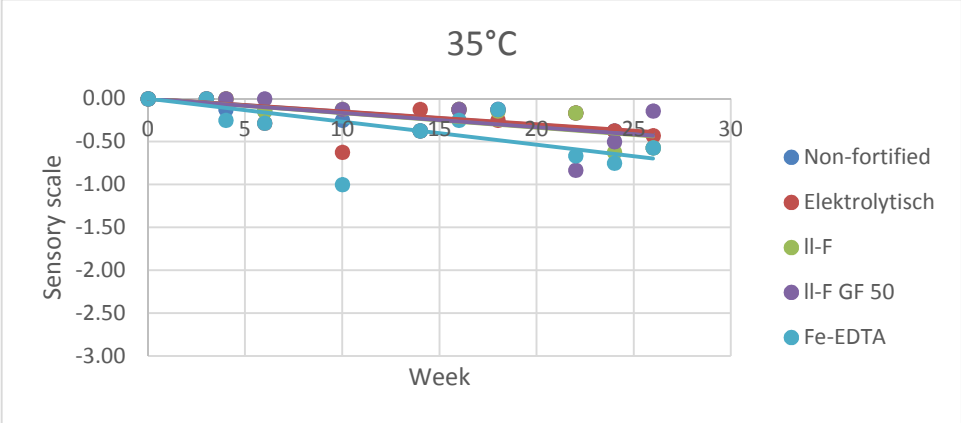


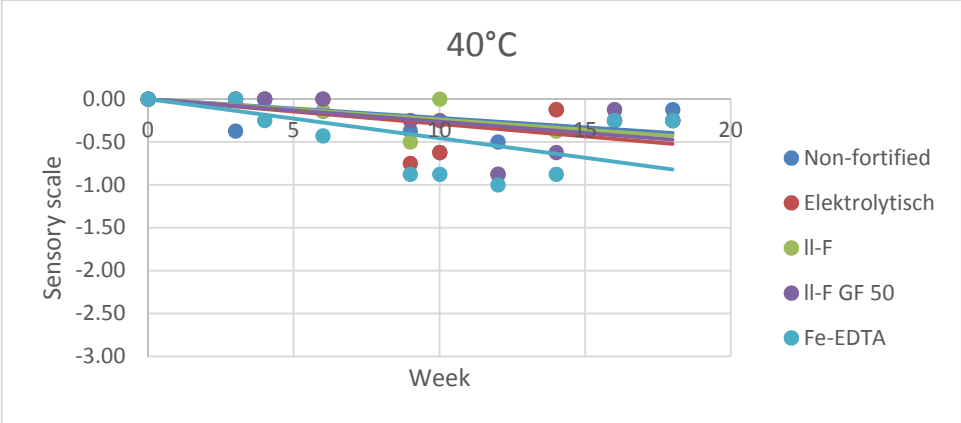


6.17 Graphs for Sensory Evaluation Texture Attribute (grouped according to storage conditions)

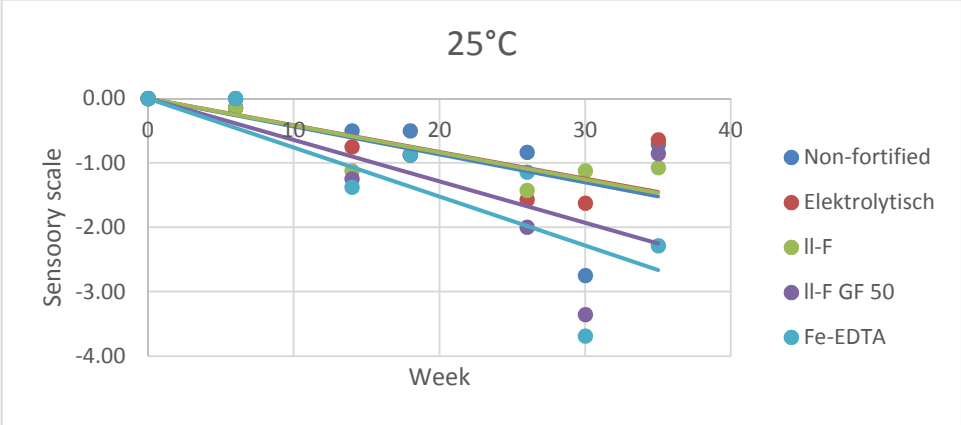


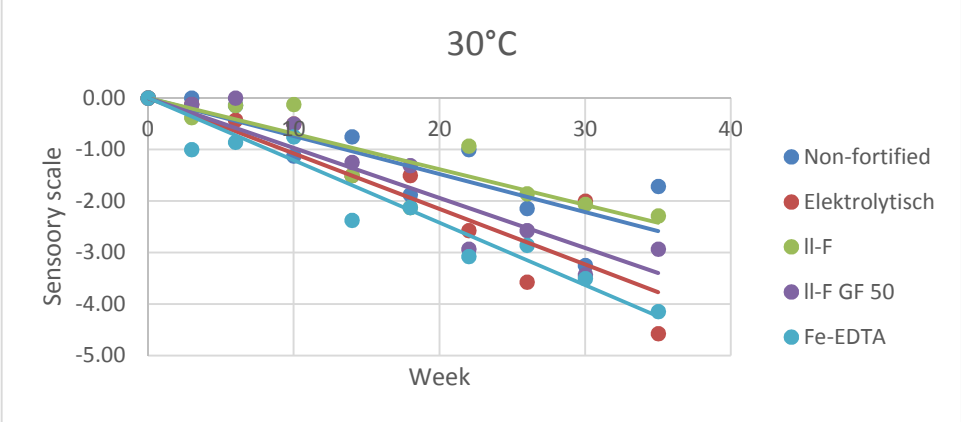


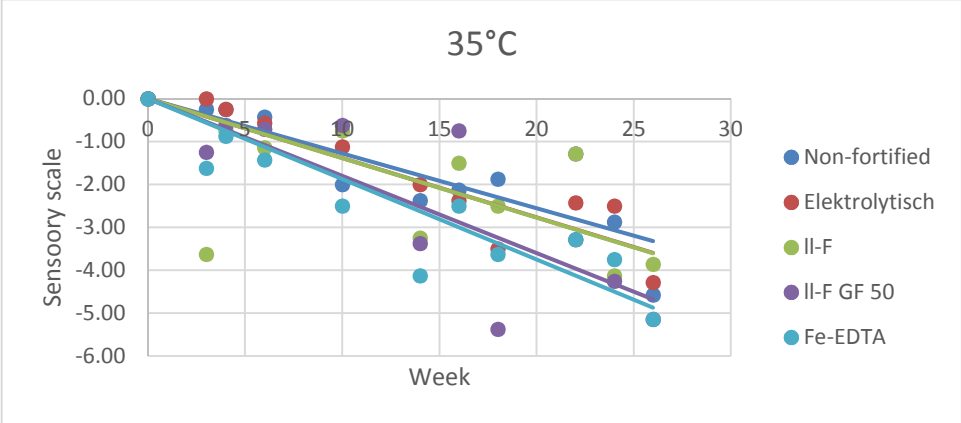


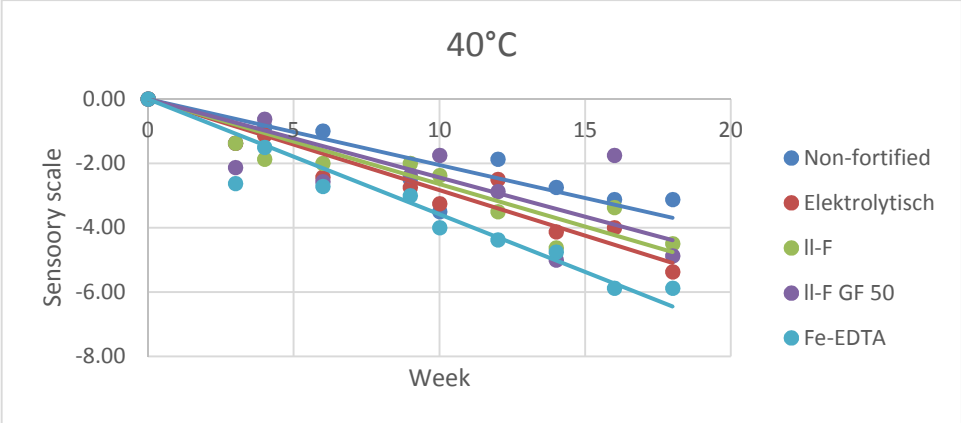


6.18 Graphs for Sensory Evaluation Flavour Attribute (grouped according to storage conditions)









6.19 Packaging Material Specifications

F-7800-01V1

Jackway Convertor Industries Pte Ltd
18 Tuas West Avenue, Singapore 638434 Website: www.jackway.com.sg
Tel +65 6861 6533 Fax +65 6861 2633 Email: enquiry@jackway.com.sg
Co. Reg. / GST Reg. No.: 199607136W-PTE-01

CERTIFICATE OF ANALYSIS

CUSTOMER :
DATE : -
PRODUCT DESCRIPTION : STANDARD STOCK
DIMEMSION : 275mm(W)x 1000m(L)
SO NO. : R-52515
COMPOSITION : OPP20/PP20

	PHYSICIAL PROPERTIES		UNIT	SPECIFICATION	RESULT	REMARK
1	THICKNESS		um	**40±10%**	**41.4**	
2	WIDTH		mm	**275±5**	**275**	
3	REPEAT		mm	**175**	**175**	
4	HOT SEALING		^{0}C (@0.2Sec. 530KPa)		**160**	
5	SEALING STRENGTH		Kg/15mm	**>0.7**	**0.806**	
6	C.O.F	STATIC		**< 0.5**	**0.269**	
		DYNAMIC		**< 0.3**	**0.167**	
7	WINDING DIRECTION				→	
8	APPEARANCE			**GOOD**	**GOOD**	

- RESULT FOR REFERENCE ONLY

TESTED BY:

CAROL LIM