ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

Original Paper

# QUALITY EVALUATION OF DRIED NOODLE WITH SEAWEEDS PUREE SUBSITUTION

*Eko Nurcahya Dewi*

Fish Poduct Processing Technology Study Program, Faculty of Fisheries and Marine Sciences, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang 50275, Central Java, Indonesia

Received : February, 22, 2010 ; Accepted : November, 15, 2010

## ABSTRACT

*The objective of this study was to compare dried noodles made of different type of seaweeds puree and then were compared to noodle which was made without any seaweeds puree subsitution. Different seaweeds puree (E.cottoniii, G. verucossa and mixed beetween them) were subsituted in proportion of 30% in the noodles. The results showed that subsitution of seaweeds puree increased the moisture, crude fiber, ash and iodine content of dried noodles compared to noodle without seaweed puree. The moisture contents : 10.08 ± 2.02 to 13.94% ± 0.84, fat 1.26 ± 0.22 to 2.49 ± 0.81%, crude fiber 2.00 ± 0.4 to 2.25% ± 0.18 and carbohydrate contents 63.37 ± 3.8 to 68.47 % ± 1.5. Iodine concentration in dried noodle with seaweed substitution about 1.06 ± 2.80 to 1.43 ± 0.76 ug/g, protein content 11.84 ± 1.03 to 12.42 ± 0.40 and the carbohydrate content 63.37 ± 3.80 to 68.47 ± 1.59. Significantly tensile strength (p<0.05) were found between the treatments of dried noodles. Higher water absorption by the seaweed lead to softer and spongier textural intensities in the noodles. However, different pattern was observed in the protein and carbohydrate content. The subsitution of different seaweeds puree did not give any significant influence (p>0.05) only for to the taste and colour of dried noodles.*

**Key words** : Dried noodle; seaweeds puree subsitution ; quality; sensory evaluation

**Correspondence**: Phone/Fax: +62-24-76480685 ; e-mail: nurdewisatsmoko@yahoo.com

# INTRODUCTION

Noodles are very thin form mostly made of wheat flour, egg and water, the dough then are sheeted, rolled, cutted, dried and boiled in water. Noodles still have an attraction for consumers of all ages. Nowadays dried noodles become widespread throughout the countries including USA, Europa and Africa since their practice and has a longer shelf life.

In the manufactur of noodle, wheat flour is needed as the main ingredient to form elasticity, hardnes as well as a source of protein and carbohydrate. The good quality of noodle is characterized by firm and elastic texture due to wheat flour function as a binding agent during dough formation. In various industrial applications as well as food processing practices, seaweeds have been employed as sources of hydrocolloids, thickeners, or gelling agents. A subtitution of seaweed puree, gives the same properties on the firmness and elastic noodles texture formation. Since seaweed gel compositions have the same properties as a gel former and it contribute structure formation during dough formation

The key quality attributes in the evaluation of noodles include colour and texture are important quality factors since it is associated with flour. People prefer noodles with hard texture, strong and elastic when it is served. Cooked noodles should be free from surface stickeness with a firm, chewy and elastic or resilient bite (Miskelly, 1996 ; Chang and Wu, 2008). Nowadays, there is a trend of short supply and higher prices of wheat flour, make manufactures of noodle are searching for a new formula for the next noodle generation that can be higher in protein, better quality and yet cheaper. Different types of flour on noodle making will result in different of noodle texture. The weakening effect on textural

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

attribute occured with subsitutional seaweed powder (Chang and Wu, 2008), so it may minimized or neglacted by using a puree seaweeds that may produce strong dough during gelatinisation process. Seaweed, either in dry or fresh form, is a nutritious vegetable, since it is low in calories, rich in vitamins, minerals, and dietary fibers.

Yap and Chen, (2000) defined a*gar* as the dried hydrophilic colloidal subtances extracted from seaweeds with polysaccharides content. It can be extracted from *Eucheuma* and *Gracillaria.* In general agar has double functions both as thickener and gel former. As a gel former, it contributes structure formation even their gel obtain chemically are different from one another as shown by Angka and Suhartono, 2000. They stated that *E. cottonii* had an elastic gel and it consisted of a unit of Galactosa-4-sulfat and anhydro-D-Galactosa, whereas *Gracilaria verrucosa* consisted of a complex mixture of polysacharides which the backbone structure of alternating 1,3 linked galactopyranose and galactopyranose with brittle gel characteristic. These properties comprise their ability to have a good consistency and plasticity. Those properties could be quite applicable for noodlemaking. *E.cottoniii* contains of water 13.90%, protein 2.69%, fat (0.37%), ash (17.09%), crude fiber (0.95%) and iodine (2.83%) of dried basis whereas *G.verrucosa* consist of : 19.01%, 4.17%; 1.20 %; 14.08% n ; 2.3 % and 1.37% respectively (Suryaningrum, *et al* ., 2003).

Generally, research on noodles making are based on their quality of product which is produced from wheat flour since it may vary widely on its protein content (Habernicht, *et al.,* 2002). However, there are very rare research on seaweeds noodles, moreover the noodle quality should always be met to Indonesian National Standart (INS)/(Badan Standarisasi Nasional) 1994, of dried eggs noodle.

The quality of dried noodle according to The INS should has the following compositions : maximum 10% for moisture content, minimum 8% for protein content and maximum 3% for ash content, respectively. Noodle quality is also evaluated in iodine content, tensile strength and consumer acceptability in term of their taste, colour , flavour and texture.

# MATERIALS AND METHODS

## Materials

Raw materials used were high protein wheat flour "Cakra "brand, *E.cottonii* and *G.verrucosa* seaweeds puree. The seaweeds ware harvested from Hindian Ocean Coast of Yogyakarta. Others materials used were whole chicken eggs, cooking oil and water.

## Methods

Basically, manufacturing process of dried noodle consists of two following processes : seaweeds puree preparation and dried noodles preparation.

## Seaweed Puree Preparation

300 g dried seaweed was soaked in water overnight, washed and drained. Dried seaweed was finely chopped, blended with 100 g water and passed through a grinder to obtain a homogenous mixture. The mixture were then boiled after subsitution of 1200 g water (the comparison of seaweed and water were 1 : 4, it based on the dried seaweed weight), stirred until it became a puree (550 g).

## Dried noodles preparation

Noodles were manufactured according to a combination method described by Wirjatmadi, *at al.,* (2002) and a local methods from traditional processor at Semarang.

All others materials were mixed, then seaweeds puree (550 g) was added in the mixture. Subsitution of 50 g water was necessary to make stiff and crumbly dough piece. The dough was rounded and covered with a plastic sheet and allowed to rest for 20 min at room temperature. Subsequently, the dough was sheeted on a noodle-making machine to form a noodle sheet. The sheet was then rolled and passed through cutting blades to cut into noodles strands desired witdh (2 mm). In order to prevent noodles sticked together, cooking oil was added to the strands. For the manufacturing of dry noodles, uncooked wet noodle strands were dried on the cabinet drier at 90ºC for 15 minutes .

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

The formulation of dried noodle with seaweeds puree subsitution is presented on the **Table 1.**

**Table 1.** Formulation of dried noodle with seaweeds puree subsitution (%)

| | Ingredients | MO | Treatments | | |
|---|---|---|---|---|---|
| | | | **ME** | **MG** | **MC** |
| 1. | Wheat flour (g) | 87.28 | 48.88 | 48.88 | 48.88 |
| 2. | *E.cottoniii* seaweeds (puree/g) | - | 38.40 | - | 19.20 |
| 3. | *G.verrucosa* seaweed (puree/g) | - | - | 38.40 | 19.20 |
| 4. | Whole chicken egg (g) | 8.21 | 8.21 | 8.21 | 8.21 |
| 5 | Water(g) for doughmaking | 3.49 | 3.49 | 3.49 | 3.49 |
| 6. | Cooking oil (g) | 0.6 | 0.6 | 0.6 | 0.6 |

Note :
ME = 30% *E.cottoniii* seaweeds puree substitutions,
MG = 30% *G. verucossa* seaweeds puree substitution,
MC = mixed 15% *E.cottoniii* and 15% *G. verucossa* seaweeds puree subsitution and
MO as a control or without any seaweeds puree substitution

## Chemical and physical Analysis

The following parameters : proximate analysis (moisture, protein, fat and ash) were determined by AOAC methods (1984), crude fiber was evaluated using the residues that remained after extraction by acid and alkaline hydrolysis (AOAC, 1984), carbohydrate by different (Slamet, *et al.*, 1990), iodine method according to Slamet, *et al.*, *(*1990). Tensile strength test which was comprised springeness, cohesiness and hardness ware performed on five strands of rinsed noodle 5 minutes after cooking using a Texture profile analysis (TPA) using a TA-XT2 *Texture analyzer*. A set of 5 strands was placed parallel on a flat metal plate and compressed crosswise twice of their original height. From force time curve of the TPA springeness, cohesiness and hardness were determined according to the discription on the curve ( Felleh, 2000 ; Park and Baik, 2003).

## Sensory evaluation

Sensory evaluation which consisted of taste, colour, flavour and texture were analysed by using score sheet (Soekarto,1985). Sensory evaluations were conducted by 30 semi trained panelists. The product acceptance was evaluated using a 9-point Hedonic Scale of ‘9’ *for extremely like* and ‘1’ for *extremely dislike*. Noodles are preferred from color which is light to dark, firmess from the force required to comprises noodles, stickness : the degree to noodle sticks on the surface of teeth after chews and wetness : the amount of moisture on noodle surface.

## Statistical Analysis

A complate random block design with 3 differents treatments ware applied in this study. Each treatment was replicated 3 times. The treatments were ME for 30% *E.cottoniii* substitutions, MG for 30% *G. verucossa* substitution and MC for the mixed 15% *E.cottoniii* and 15% *G. verucossa* and MO as a control or without any seaweeds puree substitution. Data on proximate compositions, iodine content and tensile strength were collected and tested with analysis of variance. The HSD test was carried out to find out the differences among the treatments for proximate analyses, iodine tensile strength profiles, crude fiber and sensory evaluations at a significance level of $p$ <0.05 throughout the study (Gomez dan Gomez,1995). The sensory evaluations data were tested with Friedman test (Steel and Torrie,1980).

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

# RESULTS AND DISCUSSION

## Chemical evaluation

Moisture contents of different noodles treatments were significantly affected by the subsitution of seaweed s puree. It was obvious that subsitution of seaweeds puree increased moisture content and it was significantly different *(p<0.01)* to the control (**Table 2**).

**Table 2.** Chemical and physical composition of dried noodle at different subsitution of seaweeds puree

| Composition | Seaweeds Puree Subsitution | | | |
|---|---|---|---|---|
| | **M0** | **ME** | **MG** | **MC** |
| Moisture (%) | 10.08 ± 2.02$^{c}$ | 13.94 ± 0.84$^{a}$ | 12.63 ±0.97$^{ab}$ | 11.89±0.17$^{b}$ |
| Protein (%) | 13.41 ± 0.29$^{a}$ | 11.84 ±1.03$^{b}$ | 12.42 ±0.40$^{b}$ | 12.11 ±1.32$^{b}$ |
| Fat(%) | 1.22 ± 0.96$^{c}$ | 2.49 ±0.81$^{a}$ | 1.26 ±0.22$^{c}$ | 2.12 ±1.02$^{b}$ |
| Crude Fiber(%) | 1.69 ±0.54$^{c}$ | 2.25 ±0.18$^{a}$ | 2.06 ±0.53$^{b}$ | 2.00 ±0.40$^{b}$ |
| Carbohydrate(%) | 70.17 ±0.76$^{a}$ | 63.37±3.80$^{c}$ | 64.21±2.80$^{c}$ | 68.47±1.59$^{b}$ |
| Ash (%) | 0.89 ± 0.32$^{c}$ | 1.44 ± 0.45$^{a}$ | 1.18 ± 0.20$^{b}$ | 1.46 ± 0.46$^{a}$ |
| Iodium (µg/100g) | 0.86 ±0.76$^{d}$ | 1.43 ±0.76$^{a}$ | 1.0 6±2.80$^{c}$ | 1.24 ±1.59$^{b}$ |
| T. Strength (mm/g N) | 3.49 ± 0.73$^{a}$ | 1.33 ± 0.30$^{c}$ | 2.60 ± 0.34$^{b}$ | 2.67 ±0.51$^{b}$ |

The moisture content of noodle control was lower compared to those other treatments. The highest moisture content (13.94%) was found at the *E.cottonii* seaweed puree subsitution. Moisture content on the treatments were at the range of 11.89 to 13.94 %. This value were higher than the maximum values on the dried noodle based on ISN (1994) which was maximum 8 % for the first quality and 10% for the second quality. The higher moisture content found in seaweed noodles might be due to water holding capacity of fibers and polysaccharides in seaweed during the dough formation.

Chapman and Chapman (1980) reported that Eucheuma has characteristic as a hydrocolloid and brittle gel. After the heat treatment required for the solubilization, these macromolecules have a tendency to aggregate spontaneously during cooling and to create junction zones required for gelation. This macromolecule kinking allows the chain to form helices with other chains. In iota type from *E.cottoniii* , the seaweed sulfate groups which is located only on the outer part of the helical chain will absorb water. Seaweed puree was consisted of smalls particles hence when it mixed with others components in the noodle doughmaking would result an unhomogen dough and resulted a water adsorbtion (Lahaye, 2001).

In comparison to that research was done by Dat *et al* (2004) in noodle which was made of 50 % : 50% wheat and tapioca flour, the water content in the seaweeds noodle was relatively high since wheat flour as function of binding agent.

## Protein Content

It can be seen from **Table 2,** that there was a decrease in protein content in the noodles with seaweeds subsitution. This could be assumed that the present of seaweeds as wheat flour substitution decreased the protein content in the noodle. Protein at dried noodle mainly comes from wheat flour as well as from dried processed which could affect released a part of water, hence product became crispy and thoughness.

From statistical analyses it was found that subsitution of different seaweeds puree affected the protein content of dried noodle differ significantly (*p<0.05*). Yap and Chen, (2001) reported there was a decreased on protein content on the wet noodle when seaweds subsitution proportion were raised.

Protein content in this research was at range between 11.8 -12.42 %, these value were still met the values in the first quality dried

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

noodle based on ISN (1994) which was 11% for minimum protein content.

**Fat content**

**Table 2** presented there was an increase in fat content on the treatments with subsitution of seaweeds puree (ME and MC) than control dried noodle. Wirjatmadi, *et al.,* (2002) reported there was 0.49% of fat content on their wet noodles that made from Eucheuma seaweed.

Fat content was at the range between 1.22 – 2.49%, while The Ministry of Health required a 3.3% fat content on the wet noodle. These results most probably due to naturally fat present in seaweeds. It was also assumed that the fat content came from the cooking oil which it used to prevent stickiness between strands noodles.

## Crude fiber content

Results showed there were an increasing crude fibers on the treatments, these were related to higher amount of crude fiber in *E.cottoniii* 36.03% and *G.verrucosa* 10.51% seaweeds (Suryaningrum, 2003)

It was found there was a significant different *(p<0.05)* on crude fiber content between control noodle to treatments noodles with different seaweeds pure (ME,MG and MC). These assumption was related to Dat, *et al.,* (2004) who found that noodle made of mixed 40 % maizena flour and 60% sago flour content only 0.82% crude fiber / 100 g noodle .

The crude fiber content in this research was higher compared with was found by Wirjatmadi, *et al.,* (2002), who studied on the 30% *Eucheuma* substitution. Its contained only 1.59% of crude fiber content per 100 g noodle. The result was also higher compared that reported by Chang and Wu 2008) who worked on noodles formulated with flour that processed from green seaweeds *Monostroma nitidum* was range 0.1 to 0.45% for eggs noodles with subsitution 4.6 and 8% green seaweed *Monostroma nitidum* powder respectively.

From the above statements, it could be said that seaweeds contained a higher amount of crude fibre especially on the puree form than powder form. Most of seaweed dietary fiber can binds bile salts derived from cholesterol and therefore lowers blood cholesterol levels and the risk of coronary heart disease. Moreover it can overcome constipation problems and slow the rate of sugar absorption and reduce the risk of diabetes.

## Carbohydrate Content

According to **Table 2,** it was a decrease on carbohydrate content in dried noodle among treatments with substituted by seaweeds puree. Carbohydrate content in seaweed is only small amount since it appears in crude fiber form.

The carbohydrate content varies between 63.37 to 70.17%. From statistical analysis it was found that subsitution of different seaweeds puree (ME,MG) affected carbohydrate content. There was significantly different *(p<0.05)* between dried noodle control and noodle that made of subtitution from mixed of 2 seaweeds (treatment MC). The carbohydrate content was higher than research was done by Wirjatmadi, *et al.,* (2002), they found 44.05% carbohydrate for 10% substitution of *E cottonii* powder. Whereas The Ministry of Health (Astawan, 2006) is required 14% of carbohydrate content on wet noodle.

**Ash content**

An increasing ash content from all treatments than in dried noodle control is summarized at **Table 2.** In case subtition seaweeds puree it would increase ash content on dried noodle. Naturally, sulfate and nitrate compounds are present in seaweeds. Another reason for the different ash content in the dried noodle was sulfate content which was presence as a chemical compound on colloid system from *E.cottoniii* seaweeds. Suryaningrum, *et al.,* (2003) reported there was an increased on ash content as well as increasing sulfate content.

The subtitution of *E.cottoniii* seaweed puree did not give significant effect (*p>0.05)* to ash content in dried noodle made from mixed seaweeds (**Table 2**). The smallest ash content (0.89%) was found in the dried noodle control and its different to those other treatments. The ash content in the seaweed substitution noodles were at the range of 1.18 to 1.46 %, this value were still met with the values in the first quality dried noodle based on ISN (1994) which was 3% for maximum ash content. Overall the ash content in the experiment is higher than Chang and Wu,

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

(2008) experiment, who reported for only 0.012% to 0.030% in the various level of seaweeds powders subsitution which is 4.6 and 6 %.

## Iodine Content

The highest iodine content was in *E.cottonii* (143 µg/100g) whereas the lowest was in dried noodle without subtitution of seaweed puree (0.86 µg/100g). The range iodine contents among treatments were 1.06-1.43 µg/100g. The Ministry of Health (Astawan, 2006) recommended that daily intake of 40-120 mg (0.04-0.12 µg/100g) iodine for children under five year old, 175 mg iodine for women during pregnancy, 200 mg for women during lactation, and 150 mg iodine for adult.

From statistical analysis it was found that subsitution of different seaweeds puree (ME,MG and MC) increased the iodine content of dried noodle significantly *($p<0.05$)* to control noodle (**Table 2**).

Seaweeds is wellknown as a natural resources rich in iodine content. Wirjatmadi, *et al.,* (2002) reported a higher content of iodine (98.27 – 156.89 mg/100g) for subsitution of 10 – 30% *E.cottonii* on the wet egg noodle respectively.

## Physical characteristic

Noodles should have a strong bite with a firm, smoth surface and the surface should not be sticky and elastic texture hence have a good mouthfeel. Higher scores of tensile strength located to noodles with a firm (not tough) texture, springy bite (elasticity) and smooth texture was in the control noodle 3.49 ± 0.73 mm/g.Textural properties of noodles are mainly affected by the matrix structural network of starches, glutens, subsitutional proteins, and other ingredients. These may either weaken or strengthen formations of hydrogen bonds within the noodle structure network. In this study, egg proteins, interacted with insoluble, networks of noodles, could forms table matrix structures, and could lead to higher breaking energy measurements in the instrumental textural analysis. Lower tensile strengths in seaweed noodles indicated that seaweed could not function as an effective ingredient to fortify network structures of noodle.

Park and Baik, (2004) reported the same result as in this research, they reported a rapid decrease on tensile strength indicate significant correlation with protein content. It could be seen from **Table 2,** that the higher protein content the higher its *tensile strength*. It appears that total protein obtained comes from the wheat flour that contains gluten protein and also from protein which is naturallly present in seaweed. Presence of gluten will give elastic characteristic to the product, while carrageenan content in the seaweeds resulted in elastic and firm texture.

## Sensory Evaluation

Results from sensory evaluation of the noodle are presented in **Table 3.** Sensory evaluation studies are of importance from the point of view of the processor as well as the consumer and it were assessed term of quality color, surface appearance, texture and taste were assessed.

**Table 3.** The average value on sensory test dried noodle at different subsitution of seaweeds puree

| Specification | Subsitution Seaweeds Puree | | | |
|---|---|---|---|---|
| | **M0** | **ME** | **MG** | **MC** |
| Taste | $7.1\pm 0.20^{a}$ | $7.4 \pm 0.90^{a}$ | $7.3 \pm 0.40^{a}$ | $7.3 \pm 0.10^{a}$ |
| Colour | $6.9 \pm 0.20^{a}$ | $7.3 \pm 0.40^{a}$ | $7.4 \pm 0.10^{a}$ | $7.2 \pm 0.10^{a}$ |
| Flavour | $7.0 \pm 0.14^{b}$ | $7.2 \pm 0.50^{a}$ | $7.3 \pm 0.10^{a}$ | $7.2 \pm 0.10^{a}$ |
| Texture | $6.9 \pm 0.20^{b}$ | $7.4 \pm 0.10^{a}$ | $7.3 \pm 0.10^{a}$ | $7.3 \pm 0.10^{a}$ |

Note :

- The above values were the average of three replicates ± standard deviation
- Means values within the same row followed by the same letter superscripts are not significantly different *($p>0.05$)*, the same row followed by different superscript showed a significant different *($p<0.05$)*

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

Statistically significant differences using Friedman test were not noticed with regard to taste and colour. Generally, there was little variation in taste among the treatments samples. This indicated that the taste of Eucheuma and Gracilaria seaweeds in the seaweed puree was reduced during washing. Panelis accepted seaweeds noodle samples. The undesirable taste of seaweeds were also masked by flavor components in the noodle formulation, it was also assumed that during washing, boiling, drying spesific seaweeds flavor was evaporated.

General acceptability on flavour and texture of the treatments were preferred significantly (*$p<0.05$*) more than the control noodle. In relation to colour, the consumers preference was addressed to boiled noodles which were bright and creamy. The highest score for surface appearance was noodles which have smooth and glossy surface (ME, MG, MC). Assessments are made of the three components of texture balance of softness and hardness, elasticity and smoothness. Elasticity is the most important of the textural characters. Preference was given to samples having a high degree of elasticity or springiness when gently chewed. Generally, there was little variation in taste among samples treatments.

Control noodle had a pale color and hard texture than dried treatments noodle. Miskelley, (1996) reported that noodle colour depended on the wheat flour subsitution. In dried treatments noodle the darkess and glossy the colour would result in browning reaction between seaweeds carbohydrate, wheat protein and high crude fiber content on seaweed.

There were an inverse correlation between tensile strength of ME (**Table 2**) and sensory texture (**Table 3**). The highest measurement of tensile strength the lower of cripsness texture. The best prediction of sensory texture of cripsness utilized the mean height peaks of bite and peak force of a force (deformation) curve. The increase of the sulfate content in the *Eucheuma sp* in comparison to *Gracillaria sp* is associated with decreasing brittleness of the gel state and increasing elasticity of the gel. During boiling, the long chain molecules in seweeds puree begin unfold and the wheat starch/water mixture becomes more viscous, thickens and formed a sol. While cooling, if the proportion of starch to water is suffficient, the starch moleculs form a network with the water enclosed in its meshed so produced gel and is known as the gelatinisation. The higher sulfate content the lower the tensile strength.

# CONCLUSION

The amount of moisture content, crude fiber, ash and iodine of noodles increased with subsitution of different type of seaweeds puree compared with that of the control noodle made of all wheat flour. However it decreased the protein and carbohydrate content and also its tensile strength. The range of water were 10.08 to13.94%, protein 11.83 – 12.42 %, fat 1.22- 2.49%, crude fiber 1.69- 2.25%, carbohydrate 63.37-70.17% and iodine 1.18–1.46 ug/g.

# ACKNOWLEDGEMENT

The author gratefully acknowledges kind assistance to Sri Rejeki M.Sc during preparing this manuscript. Special thanks go to Yuni Fitrianingsih alumni of Fisheries Technology Study Program UNDIP for her assistance during the experiment.

# REFERENCES

Angka, S.L. dan M.T. Suhartono. 2000. Bioteknologi Hasil Laut. Pusat Kajian Sumberdaya Pesisir dan Lautan. Institut Pertanian Bogor, Bogor. P.149.(in Indonesian )

Association of Official Analytical Chemist. 1984. Official methods of analysis. 14 th Edition AOAC.Virginia Washington.

Astawan, Made. 2006. Membuat Mie dan Bihun. Penebar Swadaya. Jakarta. P. 20-39. (in Indonesian )

Chang, H.C. and L.C. Wu. 2008. Texture and quality properties of Chinese fresh egg noodle formulated with green seaweed (*Monostroma nitidum*). *J. Food. Sci.* (Blackwell Publication) 73(8):398- 404 (1).

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

Chapman V.J. and D.J. Chapman. 1980. Seaweeds and their Uses. Third Edition.Chapman Hall London.

Dat, D.J., M. Bilang dan S.D. Amrullah.2004. Mempelajari pengolahan mie dari campuran Tepung sagu dan Tepung jagung. Jurnal Teknologi Hasil Pertanian Universitas Hasanuddin.

Felleh P, J.C. Autran and C.I. Card Vernicre. 2000. Pasta, browniss an assesment. *J. Cereal. Sci.* 32 : 215-233.

Gomez, K.A. dan A.A. Gomez. 1995. Prosedur statistik untuk penelitian Pertanian. Universitas Indonesia Press.Jakarta. P. 89-122. (in Indonesian)

Habernicht D.K, J.E Berg, G.R Carlson, PL Bruckner. 2002. Pan bread and a Chinese noodle quality in hard winter wheat genotypes growth in water limeted environment. *J. Crop Sci. 42* : 1396-1403

Indonesian National Standard (INS) (Badan Standarisasi Nasional), 1994. Standard Nasional Indonesia No. 01-2987-1992. Tentang Standar Pengujian Mutu Mi Kering. Dinas Perindustrian. Jakarta.(in Indonesian)

Kang ,C.S., Y.W, Seo, C.P. Park, and C.S. Park. 2004 Influences of Protein Characteristic on Processing and Texture of Noodles from Korean and US Wheat. *J. Crop Sci. Bio.* 10 (3) : 133 -140.

Lahaye, M. 2001. Developments on gelling algal galactans, their structure and physico-chemistry. *J. App. Phy.*13: 173-184(Kluwer Academic Publisher)

Miskelly J. 1996. Processing Technology of Noodle Product in Japan *in* J.M Kruger *et al., (ed).* Pasta and Noodle Technology. American Association of Cereal Chemist Inc.USA. P. 169 - 227.

Park ,C.S and B.K. Baik., 2004. Relationship between protein characteristic and instant noodle making quality of wheat flour. *J. Cereal. Chem.* 81 (2) : 159 -164.

Slamet D.S. M.K. Mahmud Muhilal, D. Fardiaz. 1990. Pedoman Analisis Zat Gizi. Jakarta : Departemen Kesehatan (in Indonesian)

Soekarto, 1985. Penilaian organoleptik untuk industri pangan dan hasil pertanian.Bharata Aksara, Jakarta. P.144 (in Indonesian)

Steel, R.G.D. and J.H. Torrie. 1980. Principle and Procedures of Statistic .McGraw –Hill Book Co, Inc, New York. P. 168-208.

Suryaningrum, Murtini, M.D. Erlina. 2003. Pengaruh Perlakuan Alkali dan Volume Larutan Pengekstrak Terhadap Mutu Karaginan dari Rumput Laut. *Jurnal Penelitian Pasca Panen Perikanan.* 9(5) Balai Penelitian Perikanan Laut. Jakarta. (in Indonesian)

Wirjatmadi, B., A. Merryana, S. Purwanti. 2002. Mie Kaya Iodium dan Serat Setelah ditambah Rumput Laut. Jurnal Penelitian Media Eksata 3(1):89-104. (in Indonesian)

Yap, C.Y and Chen. 2001. Polyunsaturated Fatty Acid : Biological Significance Biosynthesis and Production by macroalgae and microalgae like organism *in* Feng Chen and Yue Jiang (*Ed)* Algae and their biotechnological potensial,Kluwer Academic Publisher. P. 1-32.