RESEARCH ARTICLE

Nutrition Components of Dry Noodles From Substitution of *Aloe vera* Skin Extract and Maize's Sprout Flour

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Abstract: ***Background***: The dried noodles produced from maize raw materials soaked for 24 hours were germinated for 36 hours and the *Aloe vera* skin extracted at 80°C for 60 minutes showed high nutrients, proving that this food product has functional properties.

Objective: To check the quality of dry noodles produced from the combination of maize sprout flour and *Aloe vera* skin extract.

Subject and Method: The materials used were maize and *Aloe vera* skin. Maize was soaked for 24 hours and germinated for 36 hours and the *Aloe vera* skin was extracted at 80°C for 60 minutes. The maize sprouts obtained were then dried and floured. Then, *Aloe vera* skin extract was added, fol- lowed by other noodle-forming materials for further processing of dried noodles. The nutrient com- ponents were analyzed in the produced noodles.

Results: The maize sprout flour had 11.35% protein, protein digestibility 84.84%, starch 37.63%, phytate compound 131.09 mg/g, organic compounds 11 mg/g, and functional compounds 22 mg/g, while the noodle product had elongation of 96.15%, swelling index of 19.64%, tensile strength of 2.01 Nmm, 18 organic acids compounds (lactate, oxalate, succinic, malic, mevalonic, p coumaric, ascorbate, ferulic, panthotenic, myristic, hexadecanoic, palmitic, α-linoleic, linoleic acid, oleic, stea- rate, isobehenate and folic) and 23 functional groups in the range 527.29 - 3354.74 cm^{-1}.

Conclusion: Dry noodles produced from *Aloe vera* skin extract and maize sprout flour have functional properties.

Keywords: *Aloe vera* skin extract, dry noodles, functional food, maize, sprouts.

1. INTRODUCTION

Noodles are food generally made from wheat and are in the form of elongated strands served hot with soup or without soup. . Noodles are made of various types of raw materials such as maize. Maize is one of the most important staple food in some countries, because maize is rich in vitamins A, C, and E, carbohydrates, essential minerals, dietary fiber and protein but limited to essential amino acids, such as lysine and tryptophan [1] Maize has an antinutritional compound which can be reduced, such as by soaking and germination.

According to Ohenhen and Ikenbomeh, the soaking process [2] is natural fermentation and can dissolve the water soluble compound, while the germination process according to Mamoudou *et al*. [3] can increase the phytase enzyme to break phytic acid.

Besides, the process of germination can lead to antinutrition, increased bioavability of minerals and increased number of essential amino acids and enhancement of macronutrients in the digestive system. Narsih *et al.* [4] mentioned that soaking and germination may improve the nutrients present in cereal grains.

This research produced dry noodle made from raw maize which had been soaked and germinated for a specified time to determine and improve the added nutrient, *Aloe vera* skin extract. The content of Aloe vera extract according to Narsih *et al*. [5] is a bioactive compound that has antioxidant activity, [6] and the phytocomponent can serve as an antioxidant agent with 11 volatile compounds that act as antioxidants and have activity of 86.16%. Narsih and Agato [7] stated that dry *Aloe vera* skin has a bioactive component with 17 functional groups that provide positive functional effects on the body's metabolic system. The purpose of this study was to determine the quality of dry noodles produced from maize germinated with the addition of *Aloe vera* skin extract.

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2. MATERIALS AND METHOD

2.1. Material

Maize of Indurata (*Zea mays* indurata) with 2.5 months of age was obtained from Rasau Jaya Sub-district, Kubu Raya Regency, West Kalimantan, Indonesia. Aloe vera was obtained from Siantan Sub-district West Kalimantan, Indonesia.

2.2. Sample Preparation

The grain of the prepared maize was removed from the fruit and divided and soaked for 24 hours. It was then germinated for 36 hours. The process was continued by drying the seeds of maize at 60°C for 1 hour and bundled with a hammer mill and sieved with a size of 100 mesh. *Aloe vera* skin was extracted at 80°C for 60 minutes. The extract obtained was vacuum filtered until the filtrate was obtained. The solvent removal process in the filtrate was carried out with a vacuum rotary evaporator at 40°C for 1 hour. The filtrate was centrifuged at a speed of 5500 rpm for 10 minutes to precipitate the impurities to obtain the supernatant and precipitate. The obtained flour was mixed with *Aloe vera* skin extract, applied to dry noodles and subjected to chemical and physical test.

2.3. Biochemical Assays

2.3.1. Protein, and Starch Analysis

The protein and starch tests were determined by the Association of Official Analytical Chemists method [8].

2.3.2. Protein Digestibility

Protein digestibility of the maize samples was determined by the AOAC method. The sample (20 mg) was dissolved in 10 mL 0.1 N Walpole buffer (pH 2.0) containing 2% pepsin enzyme, incubated for 5 h at 370C in a shaking water bath and was centrifuged at 3000 rpm for 20 minutes. 5 ml of the supernatant was transferred to a new tube and neutralized by adding 5 mL of 20% TCA and incubated at ambient room temperature 30°C for 15 h. The mixture was then filtered using Whatman paper and the protein in the filtrate was analyzed by Kjedhal method. Protein digestibility was calculated as follows

$$\text{\% protein digestibility: } \frac{\text{mg N x 6,25 x 100\%}}{\text{mg sample x \% protein}}$$

2.3.3. Phytate

Phytic acid was determined according to the method of Wheeler and Ferrel [9].

2.3.4. Determination of Organic Acid

The noodles were analyzed for organic compound content using HPLC (High Performance Liquid Cromatography) under the following conditions: the column used was inferred NH_2 µm 250 x 4.6 mm, and the flow rate was 1 ml / minute. The column temperature was 300C, UV detector 290nm and using ethyl acetate / n hexane 30/70 was used as a gas carrier.

2.3.5. Determination of Functional Components

The *Aloe vera* (L.) noodle was analyzed for its functional compounds using FTIR (Fourier Transform Infra Red). The IR spectra were recorded on FTIR-8400S (Shimadzu Deutchland GmbH) spectrophotometer in KBr and polyethylene pellets. Samples were weighed at 0.01 g and homogenized with 0.01 g KBr anhydrous by mortar agate. The sample and KBr mixture were pressed by vacuum hydrolic (Graseby Specac) at 1.2 psi to obtain transparency pellet. The scanned sample was passed through infra-red, where the wave was detected by a detector connected to the computer obtaining a set of values of the tested sample spectrum Samples were usually scanned in the absorption area of 500-4000 cm^{-1}. The results of analysis were based on chemical structure, molecular binding form and certain functional group of the tested sample.

2.3.6. Cell Microstructure

The microstructure of the noodle was analyzed using SEM (Scanning Electron Microscopy) JSM T-100, JEOL, Japan. Samples were dehydrated by placing them in critical point drying equipment and then fastened with a special glue to the stub (samples holder). Samples were left to dry for ±1 day. Samples were coated with pure gold or carbon for 1 h at a coating evaporator machine prior to be observed and their microscopic photos were taken by scanning electron microscope (SEM) machine.

3. RESULTS AND DISCUSSIONS

3.1. Protein

The results of the study on protein levels concluded that the maize protein was soaked for 24 hours and germinated for 36 hours. The germination quantity was 11.35%. Rumiyati *et al*. [10] highlighted that during germination, some changes occur in protein composition. Sangronis and Machado [11] proposed that germination can increase solubility and digestibility of seed proteins such as soybeans, peas and other types of nuts.

3.2. Protein Digestibility

Protein digestibility of the maize protein soaked for 24 hours and germinated for36 hours was determined. The percentage of germination was 84.84%. The digestibility of a material can be increased after the germination process, because changes occur in the structure of the seeds and the enzyme that leads to protein hydrolysis. . Laetitia *et al*. [12] suggested that the combination of soaking and germination can increase protein digestibility because of the catabolism of reserve protein in seed and decreased antinutrient compounds. This statement is supported by Dicko *et al*. [13] who concluded that increased digestibility is a process that provides essential nutrients for growth through hydrolysis reactions.

3.3. Starch

The content of starch contained in soaked and germinated maize kernels decreased. The maize starch was soaked for 24

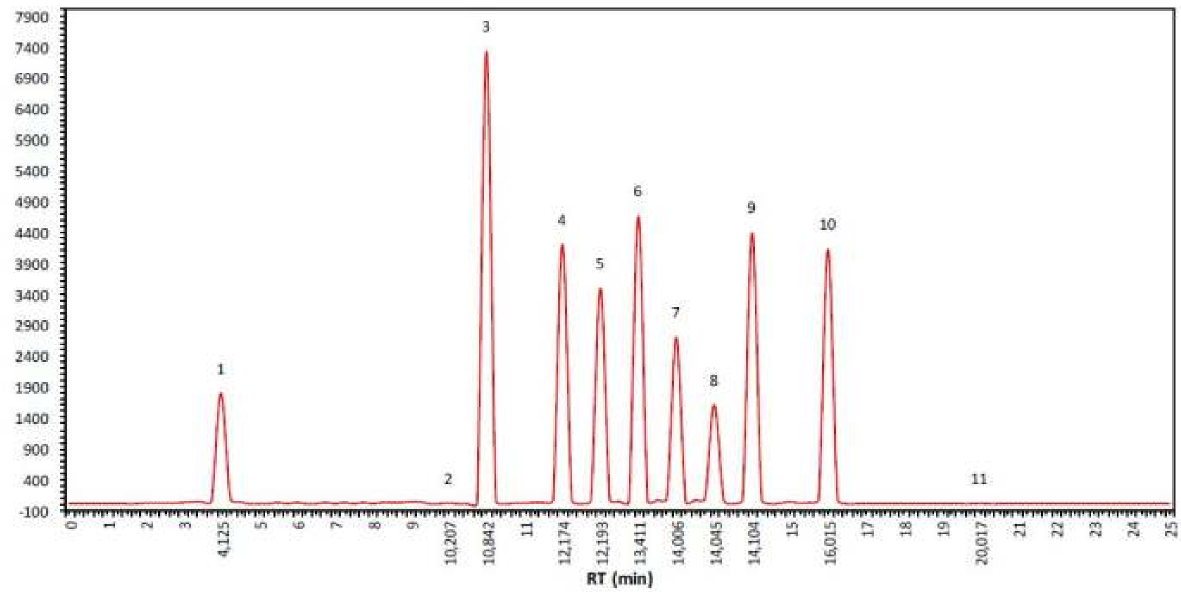

Fig (1). The organic compounds were detected on the soaking treatment 36 and 24 hours germination.

hours and germinated for 36 hours. The germination quantity was 37.63%. There was a decline of starch content observed after germination because it broke down by amylase which produced an increase in simple sugars. According to Munck [14] during the first stage of the process of germination of barley seeds, the β-glucanase enzyme degrades the cell wall of the endosperm and the α amylase lowers the starch.

3.4. Phytate Compounds

The phytate compound at the maize protein was soaked for 24 hours and germinated for 36 hours and the germination quantity was 131.09mg / g. The phytate compounds decreased with the length of soaking and germination time. According to Ohenhen and Ikenbomeh, the process of soaking [2] is a natural fermentation and can dissolve water soluble compounds, whereas according to Mamoudou *et al*. [3], the germination process can increase the phytase enzyme to break down phytic acid, besides the process of germination can lead to antinutritional change, bioavailability of minerals and an increase in a number of essential amino acids and macronutrients in the digestive system. Narsih *et al*. [4] mentioned that soaking and germination can improve the nutrients found in seeds, such as sorghum.

3.5. Organic Compounds

The organic compounds were best detected when soaked for 24 hours and germinated for 36 hours. The organic compounds detected as many as 11 compounds. The list of compounds is presented in Table **1** and Fig. (**1**).

The organic compounds detected on maize were 11 compounds with dominant compounds located at the 3rd peak of myristic acid 14364,49 µg / g, which continued at peak nos. 6,9,7,4,5,10,1,8,2,11 with compound α linoleic acid, stearic acid, linoleic acid, hexadecenoic acid, palmitic acid, isobehenic, mevalonic acid, oleic acid, pantothenic acid and folic acid, respectively. The compounds detected in maize and sprouts that tend to function as antioxidants, such as n-hexadecanoic acid or better known as palmitic acid are classified as saturated fatty acids composed of 16 carbon atoms [15]. According to Praveen *et al*. [16], this fatty acid in addition to a compound that acts as an antibacterial, is also a compound that serves as an antioxidant. According to Lakshmi and Pa [17], oleic acid serves as anti-inflammatory agent.

Table 1. Components identification of organic compound of soaked maize and sprout

Peak	Compound	Result µg/g
1	Mevalonic acid	5903
2	Pantothenic acid	16,24
3	Myristic acid	14364,49
4	Hexadecenoic acid	8478,33
5	Palmitic acid	6734,32
6	α linoleic acid	10408,30
7	Linoleic acid	8489,71
8	Oleic acid	4924,22
9	Stearic acid	9102,04
10	Isobehenic acid	5901,92
11	Folic acid	8,81

Table 2. Functional groups.

S. No.	Wave Length cm^{1}	Vibration Type	Functional Compound
1	527,29	Cincin Rocking	Aromatic
2	577,44	Cincin Rocking	Aromatic
3	606,37	Ester RCOOR	O-C-O bend
4	708,59	Fenol Ar-OH	C-OH-blend
5	762,59	Not detection	Not detection
6	859,03	Aromatic	C-C
7	934,28	Halida Asam Alifatic	C-C Stretch
8	1022,96	Eter R-O-R	C-O-C Stretch alkil aril eter
9	1080,33	Alkohol Tersier CR_3OH	C-OH Stretch
10	1156,04	Eter R-O-R	C-O-C Stretch vinil eter
11	1240,91	Ester RCOOR	C-O-C-antysim stretch
12	1343,13	No2 sterch aromatic	Nitro-No2
13	1375,91	No2 sterch aliphatic	Nitro-No2
14	1416,42	CN Strectch,pita II	Amida Primer-CONH2
15	1454,99	CH3 bend sym	Alkana Metil CH3
16	1518,64	NH bend, (bend II)	Amida Sekunder-CONHR
17	1649,79	NH bend, (bend II)	Keton R-CO-R
18	1746,22	C=C stretch konj.	Lacton
19	2145,46	C=O stretch δ-lakton	Nitril –CEN
20	2857,14	CN stretch aromatic	Metilena $-CH_2-$
21	2926,57	CH stretch alkane	Metilena $-CH_2-$
22	3331,6	NH_2 stretch	Amida Primer $-CONH_2$

3.6. Maize Noodles

Maize had been soaked for 36 hours and germinated for 24 hours, followed by manufacturing of dry noodles as a product application. In the manufacturing of maize flour, *Aloe vera* skin extract was added that was extracted at a tem- perature of 80°C for 60 minutes. The analysis tested on the resulting noodle was done physically.

The infra-red spectrum of the soaked and granulated maize is specified in Fig. (**2**), which is in the wavelength range of 527.29 to 3331.6 cm^{-1}, with 22 functional components detected (Table **2**). In Table **3** and Fig. (**2**) the bands with wavelengths 527.29 -577.44 and 1649.79-1764.22 cm^{-1} can be expressed with aromatic functional groups, whereas at wavelength 762.59 cm^{-1} , no detectable uptake results of a compound were found. The wavelength 606,37-708,59 is expressed by the alcohol functional group, and the group 859,03-3331,6 is a group of nitro, alkenes, ethers, alcohols, alkane, methylene and carboxylic acids.

3.7. Elongation

The elongation value obtained for maize noodle is 96.15%. Elongation is the ability to elongate / stretch from the initial size. Elongation value shows the characteristics of noodles. The high values indicate the characteristics of noodles that are not easily broken and the certain influence of starch bonds due to the amount of starch Maize noodles are declared to be of good quality if they have a high elongation percentage.

3.8. Swelling Index

The swelling index value obtained for dry noodle is 19.640%. The value of the swelling index is influenced by many factors including the soaking time. Yuan *et al.* [18] showed that soaking can cause starch breaks and the starch granules bind water during the heating process. According to Koswara, [19] maize has 78% amylopectin starch. Starch that has a high amylopectin component is very difficult to bind with

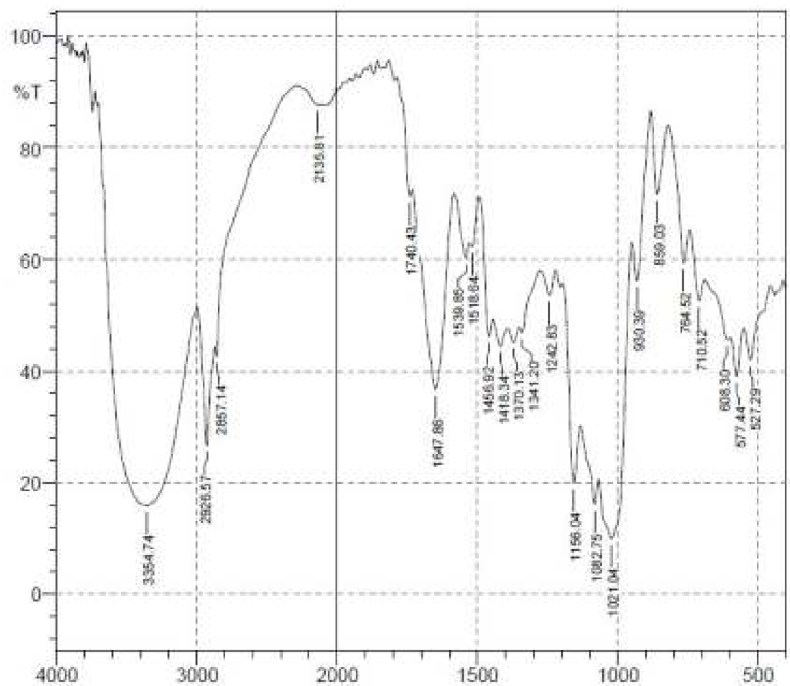

Fig (2). The infra red spectrum of the on the soaking treatment 36 and 24 hours germination.

Table 3. Components identification of organic compounds in dry noodles

Peak	Compound	Result µg/g
1	Lactic acid	74,39
2	Oxalic acid	3,92
3	Succini acid	15,41
4	Malic acid	38,37
5	Mevalonic acid	3053,83
6	P coumaric acid	26,50
7	Ascorbic acid	8,04
8	Ferulic acid	10,38
9	Panthotenic acid	30,01
10	Myristic acid	5212,72
11	Hexadecanoic acid	4511,04
12	Palmitic acid	3438,55
13	αlinoleic acid	5779,34
14	Linoleic acid	3412,11
15	Oleic acid	1929,21
16	Stearic acid	3801,74
17	Isobehenic acid	2269,09
18	Folic acid	10,78

each other because of the chain branched, so that high amylopectin starch can easily undergo gelatinization. Comparison of amylose and amylopectin affect the solubility and degree of gelatinization of starch.

3.9. Tensile strength

The tensile strength value obtained for dry noodle is 2.01N / mm. This value is influenced by the protein content of the ingredients. Riki *et al*. [20] stated that if the protein content is low, the peptide bonds are also short, so there is no need for high energy to break the bonds. Noodles produced from starch with a ratio of aminopropy and the functional properties of the patiseperti are of low quality, are strong and compact, are elastic, and have low sticky strands [21].

3.10. Starch granule test

The starch granule test on maize dry noodles using scanning electron microscopy (SEM) at 800x magnification presented in Fig**. (3)** shows a round globular granule intact. According to Mauro *et al*., [22], microscopic maize starch granules are a a mixture of molecules in linear and branched starchy granules arranged to form a ring-shaped or lamellar ring arranged centrally around the starting point, referred to as the hilm males Boyer and Shannon [23]. Maize starch granules have crystalline structures consisting of crystalline units and amorphous units. The crystalline region in most starch is composed of the amylopectin fraction, whereas the amylose fraction is present in the amorphous region.

3.11. Organic compounds

Organic compounds detected in maize noodles are as many as 18 compounds. The list of compounds is presented in Table **3** and Fig. **(3).**

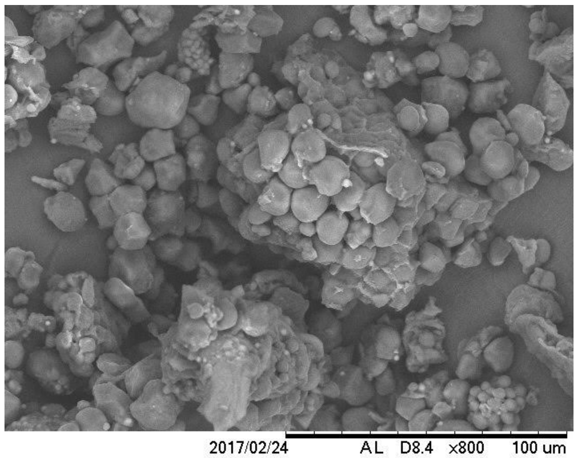

Fig (3) Microscopic Maize Strach

The organic compounds detected in maize dry noodle were 18 compounds, when compared with the organic compounds detected on the soaked and germinated maize which were 11 compounds. An increase of 7 compounds was observed. This was due to the manufacturing of maize dry noodles with added *Aloe vera* skin extract. *Aloe vera* skin extract contains important compounds, such as ρ coumaric acid. Ashish *et al*. [24] highlighted that coumaric compound is one of the main components of plant cell wall. According to Mac and Grabber [25], most coumaric acids are esterified with lignin and produce biocatalytic aromatic compounds. The aromatic compounds of coumaric in plants according to Tomas and Clifford [26] serve as antioxidants. Other newly detected compounds are lactic acid, oxalic acid, succinic acid, malic acid, ascorbic acid and ferulic acid which have a positive effect on the body's metabolic system.

3.12. Functional groups

The infrared spectrum of maize dry noodles is presented in Fig. (**5**), where the wavelengths range from 527.29 to 3354.74 cm^{-1} with 23 detected components (Table **4**). The infrared spectra presented in Fig. (**5**) and Table **4** have wavelengths 527.29 to 3354,74 cm^{-1}, with 23 functional groups detected (Table **4**). Bands at 527,29, 577,44, 859,03,2135,81cm^{-1} wavelengths can be expressed with aromatic functional groups, whereas wavelengths 608.3 to 1242.83 are OH blend, 1341,2 to 1370,13 is a nitro group, 1481.34 to 1539.86 is the group of primary amides and 2926,5 to 3354,73 cm^{-1} is a methylene group. When compared with functional groups detected in soybean and sprouted soybean, there was a difference of infrared spectra, where the soybean and sprouted seeds detected 22 functional groups, while in the noodles 23 compounds were detected. This means that there is a new compound at the wavelength of 1518.64 cm^{-1}, the secondary amide-CONHR.

CONCLUSION

Immersion for 24 hours and germination for 36 hours affect protein content, protein digestibility, starch, phytate, organic compound and functional group of maize. In the resulting flour, the *Aloe vera* skin extract was added which was applied to noodles, causing an increase in organic compounds and functional groups.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable

HUMAN AND ANIMAL RIGHTS

No animals/Humans were used for studies that are the basis of this research.

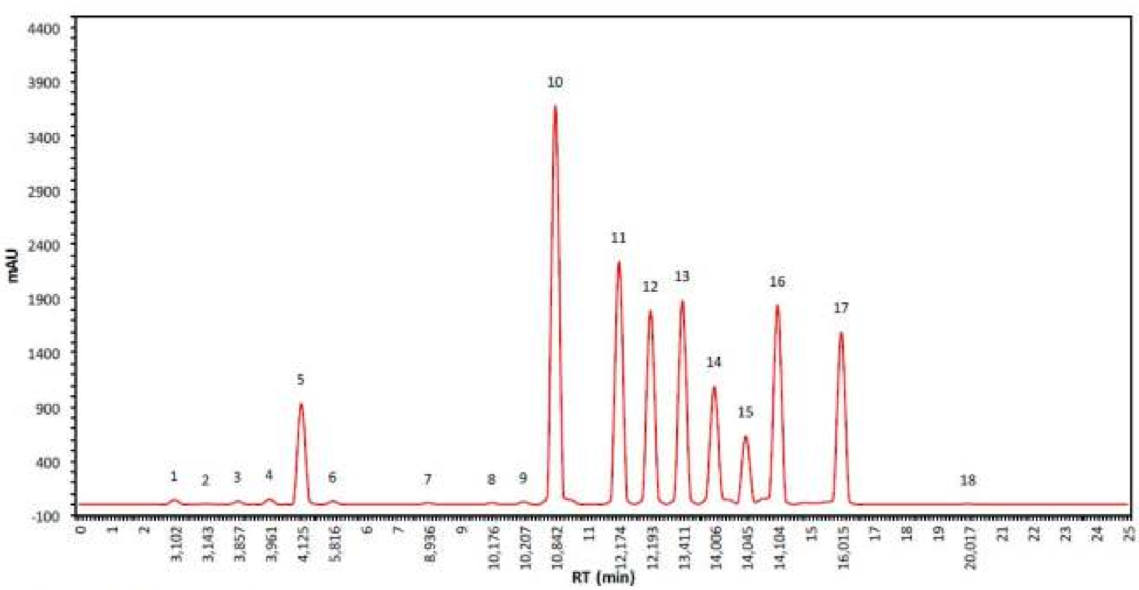

Fig (4). Organic Compounds in Maize Noodles.

Table 4. Components of functional groups of maize dry noodles

S. No.	Wave Length cm^{1}	Vibration Type	Functional Compound
1	527,29	Ring Rocking	Aromatic
2	577,44	Ring Rocking	Aromatic
3	608,3	Ester RCOOR	O-C-O bend
4	710,52	Fenol Ar-OH	C-OH-blend
5	764,52	Un detectition	Un detectition
6	859,03	Aromatik	C-C
7	930,39	Aliphatic acid halide	C-C Stretch
8	1021,04	Eter R-O-R	C-O-C Stretch alkil aril eter
9	1082,75	Tersier CR$_2$OH	C-OH Stretch
10	1156,04	Eter R-O-R	C-O-C Stretch vinil eter
11	1242,83	Ester RCOOR	C-O-C-antysim stretch
12	1341,2	No2 sterch aromatic	Nitro-No2
13	1370,13	No2 sterch alifatik	Nitro-No2
14	1418,34	CN Strectch,pita II	Amida Primer-CONH2
15	1456,92	CH3 bend sym	Alkana Metil CH3
16	1518,64	NH bend, (pita II)	Amida Sekunder-CONHR
17	1539,84	NH bend, (pita II)	Amida Sekunder-CONHR
18	1647,86	C=C stretch konj.	Keton R-CO-R
19	1740,43	C=O stretch ó-lakton	Lakton
20	2135,81	CN stretch aromatic	Nitril –CEN
21	2857,14	CH stretch in alkane	Metilena –CH$_2$-
22	2926,57	CH stretch in alkane	Metilenan –CH$_2$-
23	3354,74	NH$_2$ stretch	Amida Primer –CONH$_2$

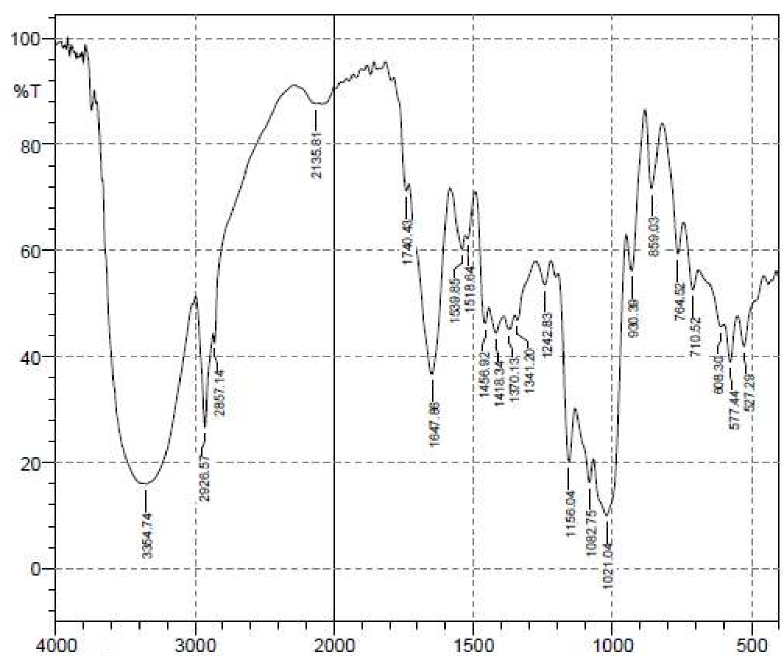

Fig (5) infrared spectrum of maize dry noodles

CONSENT FOR PUBLICATION

Not applicable

CONFLICT OF INTEREST

The authors confirm that there is no conflict of interest, even though DRPM DIKTI supported the research.

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