DAFTAR PUSTAKA

Abro'r, R. W, dkk. (2019). Pengaruh gliserol terhadap sifat mekanik bioplastik pati kulit pisang raja (Musa paradisiaca L). *Prosiding Seminar Nasional*. Hal 252-257.

Aidah, S. N. (2020). *Jadi Jutawan dengan Berbisnis Buah Pisang.* Yogyakarta: KBM Indonesia.

Aldera, A. C., Sari, A. I., & Diasnita. (2020). *Bank Gizi : Materi da Soal.* Jakarta: Ilmu Giziku.

Andahera, C., Sholikhah, I., Islamiati, D. A., & Pusfitasari, M. D. (2019). Pengaruh penambahan jenis dan kosentrasi plasticizer terhadap kualitas bioplastik berbasis selulosa dari tandan kosong kelapa sawit. *Indonesian Journal of Pure and Applied Chemistry*. Vol. 2, No. 2, hal 46-54.

Ardhani, A. D., Yoga, A. P., & Louis, I. K. (2020). Dua sisi mata uang : Kebijakan publik dan penanganan sampah plastik di Indonesia. *BEM Universitas Sanata Dharma Kabinet Solidaritas Aksi.*

Asngad, A., Ervian, J. M., & Cahyo, D. S. (2020). Kualitas Bioplastik dari umbi singkong karet dengan penambahan plasticizer gliserol dengan sorbitol dan kitosan. *Jurnal Bioeksperimen*. Vol. 6, No. 1, hal. 36-44.

ASTM D570-98. (1999). *Standart Test Method for Water Absorption of Plastics.*

ASTM D882-12. (2012). *Standart Test Method for Tensile Properties of Thin Plastic Sheeting.*

Coates, John. 2000. *Interpretation of Infrared Spectra, A Practical Approach.* Encyclopedia : Chichester.

Deri, A., Iskandar, T., & Anggraini, S. P. (2020). Optimasi kadar abu pada campuran biochar dengan pupuk NPK melalui metode coating. *Prosiding Seminar Nasional Teknologi Industri*. Hal C3.1-C3.6.

Elisusanti, Illing dan Muhammad, N. A. (2019). Pembuatan Bioplastik Berbahan Dasar Pati Kulit Pisang Kepok/Selulosa Serbuk Kayu Gergaji. *Cokroaminoto Journal of Chemical Science*. Vol. 1, No. 1, Hal 14-19.

Hadi, S. (2019). *Teknologi Bahan Lanjut.* Yogyakarta: Andi.

Hidayat, N., S. P., & A. R. (2020). *Teknologi Fermentasi.* Bogor: IPB Press.

Ikhwanuddin. (2018).*Pembuatan dan karakterisasi bioplastik berbasis serbuk daun pisang batu dan CMC yang diperkuat oleh GUM ARABIC*. Program Studi Magister (S2) Fisika. Universitas Sumatera Utara.

Intandiana, Sinda, Akbar Hanif Dawam, Yus Rama Denny, Rahmat Firman Septiyanto dan Isriyanti Affifah. (2019). Pengaruh Karakteristik Bioplastik Pati Singkong Dan Selulosa Mikrokristalin Terhadap Sifat Mekanik Dan Hidrofobisitas.*Jurnal Kimia Dan Pendidikan*.

Isnaini, S. U. (2019). *Pengaruh penambahan sorbitol terhadap karakteristik plastik biodegradable berbahan selulosa dari cangkang buah nipah (Nypa fruticans)*. Islam Negeri Walisongo Semarang.

Judawisastra, H. 2017. Water Absorption And Its Effect On The Tensile Properties Of Tapioca Starch/Polyvinyl Alcohol Bioplastics. *Material Science and Engineering.*

Krisnadi, R., Handarni, Y., & Udyani, K. (2019). Pengaruh Jenis Plasticizer Terhadap Karakteristik Plastik Biodegadable dari Bekatul Padi. *Jurnal Sains dan Teknologi*. Vol. 1, No. 1, hal. 125-130.

Kusnandar, F. (2019). *Kimia Pangan Komponen Makro.* Jakarta Timur: PT. Bumi Aksara.

Lestari, R. 2006. *Karakteristik Fisik dan pH selai pisang raja*. Program Studi Fisika. Institut Pertanian Bogor.

Maladi, I. (2019). *Pembuatan Bioplastik Berbahan Dasar Pati Kulit Singkong (manihot utilissima) dengan penguat selulosa jerami padi, polivinil alkohol dan Bio-COMPATIBLEZINK OKSIDA*. Program Studi Kimia. Universitas Islam Negeri Syarif Hidayatullah.

Marlina, L. & Cengristitama. (2020). Pengaruh variasi suhu perendaman terhadap karekteristik pati termodifikasi dari kulit singkong dengan substitusi sari kedelai. *Pasundan Food Technologi Journal (PFTJ)*. Vol 7, No 3, hal. 102.

Masthura. (2019). *Pengaruh jenis plasticizer terhadap edible film berbasis keraginan Eucheuma cottonii*. Program Studi Kimia. Universitas Islam Negeri Ar-Raniry Banda Aceh.

Mawardi, I., & Lubis, H. (2019). *Proses Manufaktur Plastik & Komposit.* Yogyakarta: C.V Andi OFFSET.

Ma'arif, Lukman. (2019). *Biodegradasi Bioplastik Berbahan Dasar Umbi Ganyong dengan Penambahan Sorbitol dan CMC (Carboxy Metyl Cellulose) dalam Media Tanah dan EM4 (Effective Microorganisme 4)*. Program Studi Kimia. Universitas Islam Negeri Sunan Kalijaga

Melani, A., Putri, D., & Robiah. (2019). Bioplastik dari pati kulit pisang raja dengan berbagai bahan perekat. Vol 4, No. 2, hal 1-7.

Melly, A., Septyana A.P & Rosdiana Moeksin. 2015. Pembuatan Bioetanol Dari Kulit Pisang Raja (Musa Sapientum) Menggunakan Metode Hidrolisis Asam dan Fermentasi. *Jurnal Teknik Kimia*. Vol. 21 No. 2.

Muhaiminin, M. (2019). *Plastik Biodegradable Dari Kulit Singkong Dengan Penambahan Serbuk Batang Tembakau*. Program Studi Teknologi Industri Pertanian. Universitas JEMBER.

Mustikarani, E. D., Lestari, T., & Prayoga, G. I. (2019). *Plasma Nutfah Tanaman Potensial di Bangka Belitung.* Jawa Timur: Uwais Inspirasi Indonesia.

Ningsih, Erni Puryati, Dahlena Ariyani, Sunardi. (2019). Pengaruh Penambahan Carboxymethyl Cellulose Terhadap Karakteristik Bioplastik Dari Pati Ubi Nagara (Ipomoea Batatas L.). *Indo. J. Chem*. VOL. 7, NO. 1, Hal 77-85.

Nisah, K. (2019). Pemanfaatan ekstrak chitin dari limbah kulit udang sebagai Biokoagulan dan Film Bioplastik untuk mengurangi dampak pencemaran lingkungan. *Pusat Penelitian dan Penerbitan Lembaga Penelitian dan Pengabdian kepada Masyarakat*. Universitas Islam Negeri Ar-Raniry Banda Aceh.

Pamungkas, G. T. (2020). *Pengaruh penambahan kitosan dan gliserol terhadap sifat fisik dan mekanik film bioplastik dari kulit kentang*. Program Studi Teknik Kimia. Universitas Pertamina.

Putra, Angga Dwina, Idral Amri, Irdoni. (2019). Sintesis Bioplastik Berbahan Dasar Pati Jagung dengan Penambahan Filler Selulosa Serat Daun Nanas (Ananas cosmosus). *JOM FTEKNIK*. Vol 6.

Putra, E. P., & Saputra, H. (2020). Karakterisasi plastik Biodegradable dari pati limbah kulit pisang muli dengan plastizicer sorbitol. *Jurnal Teknologi Pertanian Andalas*. Vol. 24, No. 1, hal 29-36.

Rahmi, Ishmaturrahmi, Lelifajri, Mustafa, I., & Susilawati. (2019). *Pemanfaatan Pasir Besi untuk pembuatan Kitosan Magnetik.* Banda Aceh: Syiah Kuala University Press.

Riyanty, E. L. (2021). *Untung Berlimpah Budi Daya Pisang.* Jakarta: Bhuana Ilmu Populer.

Rozi, A. N, Novizar, N, Gunarif, T. (2020). Karakteristik Bioplastik dari Pati Biji Durian dan Pati Singkong yang Menggunakan Bahan Pengisi MCC (Microcrystalline cellulose) dari Kulit Kakao. Vol. 25, No. 01, Hal. 01-10.

Sa'o, M. T., Feonay, T. A., & Koni, T. N. (2021). Kandungan Nutrien kulit pisang kepok (Musa paradisiaca) yang difermentasi dengan cairan rumen kambing. *Jurnal Ilmu Peternakan Terapan*. Vol. 4, No. 2, Hal. 78-83.

Sapper, M., Wilcaso, P., Santamarina, M. P., Rosello, J., & Chiralt, A. (2018). Antifungal and functional properties of starch-gellan films containing thyme (Thymus zygis) essential oil. *Journal Food Control.* Doi:10.1016/j.foodcont.2018.05.004.

Sari, N. H. (2021). *Polimer Termoset.* Yogyakarta: CV Budi Utama.

Setianingsih, T., & Prananto, Y. P. (2020). *Spektroskopi Inframerah untuk Karakterisasi Mterial Anorganik*. Malang: UB Press.

Setiarto, R. H. (2020). *Teknologi Pengemasan Pangan Antimikroba yang Ramah Lingkungan.* Depok: Guepedia.

Setiawati, M. R. (2019).Peran mikroba dekomposer selulolitik dari sarang rayap dalam menurunkan kandungan selulosa limbah pertnian berselulosa tinggi. Vol.17, No. 2.

Siagian, H. S., Gultom, R. P., & Anggraini, R. (2019). *Modifikasi Alang-alang sebagai filler adsorban logam berat.* Yogyakarta: CV Budi Utama.

Siregar Faqih Maulana. (2021). *Pembuatan Dan Karakterisasi Bioplastik Berbahan Dasar Pati Sukun (Artocarpus altilis) Dengan Variasi Penambahan Kitosan Dan Sorbitol*. Program Studi S1 Kimia Fakultas

Matematika Dan Ilmu Pengetahuan Alam Universitas Sumatera Utara Medan.

Suloi, A. N. (2019). Potensi pati resisten dari berbagai jenis pisang – A Review. *Jurnal Penelitian dan Pengembangan Agrokompleks*. Vol. 2, No. 1, hal. 92-96.

Suryani, A., Poerwanto, R., & Siregar, I. Z. (2021). *Merevolusi Revolusi Hijau.* Jawa Barat: IPB Press.

Syura, I. (2020). *Pembuatan dan karakterisasi film bioplastik pati porang (Amorphophallus sp) dan kitosan dengan plasticizer sorbitol*. Departemen Fisika. Universitas Sumatera Utara Medan.

Trisunaryanti, W. (2018). *Dari Sampah Plastik menjadi bensin dan solar*. Yogyakarta: Gadjah Mada University Press.

Wahyudi, B., Kasafir, M. B., & Hidayat, M. R. (2020). Sintesis dan karakterisasi bioplastik dari pati talas dengan selulosa tandan kosong kelapa sawit. *Seminar Nasional Teknik Kimia Soebardjo Brotohardjono XVI.*

Warsiki, E., Setiawan, I., & Hoerudin. (2020). Sintesa komposit bioplastik pati kulit singkong-partikel nanosilika dan karakterisasinya. *Jurnal Kimia dan Kemasan*. Vol. 42, No. 2, Hal. 37-45.

Wiradipta, I Dewa Gede Agung. (2017). *Pembuatan Plastik Biodegradable Berbahan Dasar Selulosa Dari Tongkol Jagung*. Departemen Fisika. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Institut Teknologi Sepuluh Nopember.

Yustinah, d. (2019). Pengaruh penambahan kitosan dalam pembuatan plastik Biodegradable dari rumput laut Gracilaria sp dengan pemlastis Sorbitol. *Seminar Nasional Sains dan Teknologi.* Fakultas Teknik Universitas Muhammadiyah Jakarta

Zulmawardi dan Vilia Darma Paramit. 2019. Proses Pembuatan Pulp Selulosa Dari Limbah Jerami Padi (Oryza Satifa). *Proding Seminar Nasional Penelitian dan Pengabdian Kepada Masyarakat*. Hal. 70-75.

Lampiran 1 Gambar Alat Penelitian

1. Baskom

2. Pisau

3. Kain Saring

4. *Hot Plate*

5. Magnetik bar

6. Beaker Glass

7. *Erlenmeyer*

8. Kertas saring

9. Pipet skala

10. Gelas Ukur

11. Batang Pengaduk

12. Plat Kaca Ukuran 20 x 20

13. Mortar dan Alu

14. Blender

15. Neraca Digital

16. Oven

17. Ayakan 40 mesh

18. Ayakan 120 mesh

19. Alat Uji Kuat Tarik

20. Alat Uji Kuat Tarik

Lampiran 2 Gambar Bahan Penelitian

1. Kulit Pisang Raja

2. Jerami padi

3. *Plasticizer* Sorbito

4. Kitosan

4. Aquadest

5. Natrium Hidroksida (NaOH)

6. Asam Sulfat (H_2SO_4)

7. *Natrium Hipoklorit*

8. Asam Asetat

Lampiran 3 Gambar Sampel Bioplastik

Sampel A

Sampel B

Sampel C

Sampel D

Sampel E

Lampiran 4 Gambar Pengujian Sampel Bioplastik

A. Pengujian Daya Serap Air

(Sampel sebelum pengujian) (Sampel setelah pengujian)

1. Sampel A

(Berat sebelum pengujian) (Berat sesudah pengujian)

2. Sampel B

(Berat sebelum pengujian) (Berat sesudah pengujian)

3. Sampel C

(Berat sebelum pengujian)

(Berat sesudah pengujian)

4. Sampel D

(Berat sebelum pengujian)

(Berat sesudah pengujian)

5. Sampel E

(Berat sebelum pengujian)

Berat sesudah pengujian)

B. Pengujian Biodegradasi

(Sampel Sebelum Pengujian) (Sampel Sesudah Pengujian)

1. Sampel A

(Berat Sebelum Pengujian) (Berat Sesudah Pengujian)

2. Sampel B

(Berat Sebelum Pengujian) (Berat Sesudah Pengujian)

3. Sampel C

(Berat Sebelum Pengujian) (Berat Sesudah Pengujian)

4. Sampel D

(Berat Sebelum Pengujian)

(Berat Sesudah Pengujian)

5. Sampel E

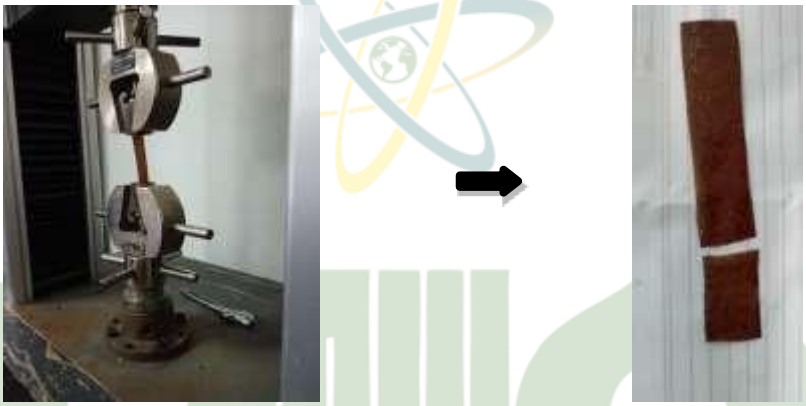
(Berat Sebelum Pengujian)

(Berat Sesudah Pengujian)

C. Pengujian Kuat Tarik

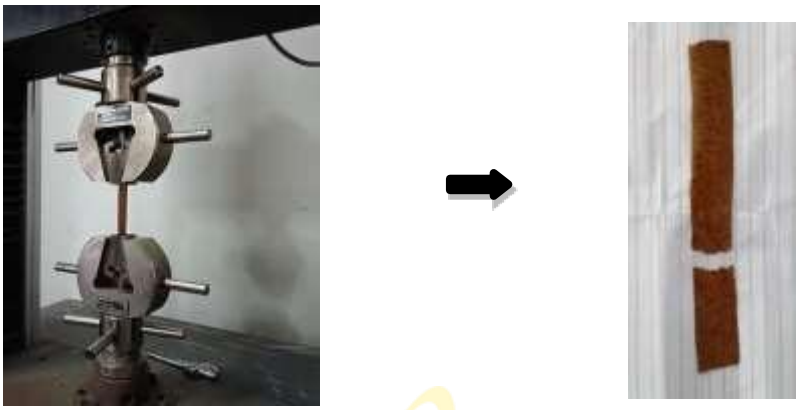
Nomor Sampel	Elongasi (mm)	Muatan Maksimum (N)	Kuat Tarik (MPa)
A	20,45504	9,47057263	3,642527936
B	13,57806	17,55359246	6,751381715
C	10,82602	21,64383172	8,324550661
D	8,11534	24,44352728	9,401356646
E	4,58584	29,21224069	11,235477192

1. Sampel A



2. Sampel B

3. Sampel C



4. Sampel D

5. Sampel E

Lampiran 5 Data Pengujian Daya Serap Air

Sampel	m_k (g)	m_b (g)	Daya Serap Air (%)
A	0,28	0,47	67,86
B	0,33	0,49	48,48
C	0,28	0,36	28,57
D	0,33	0,40	21,21
E	0,31	0,36	16,13

Data Pengujian presentase air yang diserap sampel bioplastik didapatkan dengan menggunakan persamaan (2.1). Berikut ini merupakan perhitungan daya serap air :

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

Keterangan :

DSA = Daya serap air (%)

m_b = massa sampel setelah pengujian (g).

m_k = massa sampel sebelum pengujian (g).

1. Sampel A

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

$$= \frac{0{,}47 \text{ g} - 0{,}28 \text{ g}}{0{,}28 \text{ g}} \times 100\%$$

$$= 0{,}6786 \times 100\%$$

$$= 67{,}86\%$$

2. Sampel B

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

$$= \frac{0{,}49 \text{ g} - 0{,}33 \text{ g}}{0{,}33 \text{ g}} \times 100\%$$

$$= 0{,}4848 \times 100\% = 48{,}48\%$$

3. Sampel C

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

$$= \frac{0{,}36 \text{ g} - 0{,}28 \text{ g}}{0{,}28 \text{ g}} \times 100\%$$

$$= 0{,}2857 \times 100\%$$

$$= 28{,}57\%$$

4. Sampel D

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

$$= \frac{0{,}40 \text{ g} - 0{,}33 \text{ g}}{0{,}33 \text{ g}} \times 100\%$$

$$= 0{,}2121 \times 100\%$$

$$= 21{,}21\%$$

5. Sampel E

$$\% \text{ DSA} = \frac{m_b - m_k}{m_k} \times 100\%$$

$$= \frac{0{,}36 \text{ g} - 0{,}31 \text{ g}}{0{,}31 \text{ g}} \times 100\%$$

$$= 0{,}1613 \times 100\%$$

$$= 16{,}13\%$$

- **Perhitungan persen selisih nilai uji daya serap air**

Adapun rumus untuk menghitung penurunan persen selisih adalah sebagai berikut :

$$\% \text{ Selisih} = \frac{v_1 - v_2}{v_1} \times 100\%$$

1. Sampel A ke B

$$\% \text{ Selisih} = \frac{67{,}86\% - 48{,}48\%}{67{,}86\%} \times 100\%$$

$$= 0{,}29 \times 100\%$$

$$= 29\%$$

2. Sampel B ke C

$$\% \text{ Selisih } = \frac{48{,}48\%-28{,}57\%}{48{,}48\%} \times 100\%$$

$$= 0{,}41 \times 100\%$$

$$= 41\%$$

3. Sampel C ke D

$$\% \text{ Selisih } = \frac{28{,}57\%-21{,}21\%}{28{,}57\%} \times 100\%$$

$$= 0{,}26 \times 100\%$$

$$= 26\%$$

4. Sampel D ke E

$$\% \text{ Selisih } = \frac{21{,}21\%-16{,}13\%}{21{,}21\%} \times 100\%$$

$$= 0{,}24 \times 100\%$$

$$= 24\%$$

Lampiran 6 Data Pengujian Biodegradasi

Sampel	M_0 (g)	M_1 (g)	Biodegradasi (%)
A	0,10	0,01	90
B	0,11	0,02	82
C	0,12	0,03	75
D	0,11	0,03	73
E	0,12	0,04	67

Data Pengujian biodegradasi sampel bioplastik didapatkan dengan menggunakan persamaan (2.2). Berikut ini merupakan perhitungan biodegradasi :

$$\text{Biodegradasi (\%)} = \frac{m_0 - m_1}{m_0} \times 100\%$$

Keterangan :

m_0 = massa awal sampel bioplastik (g).

m_1 = massa akhir sampel setelah dikubur (g).

1. Sampel A

$$\text{\% Biodegradasi} = \frac{m_0 - m_1}{m_0} \times 100\%$$

$$= \frac{0{,}10\ \text{g} - 0{,}01\ \text{g}}{0{,}10\ \text{g}} \times 100\%$$

$$= 0{,}9 \times 100\%$$

$$= 90\%$$

2. Sampel B

$$\text{\% Biodegradasi} = \frac{m_0 - m_1}{m_0} \times 100\%$$

$$= \frac{0{,}11\ \text{g} - 0{,}02\ \text{g}}{0{,}11\ \text{g}} \times 100\%$$

$$= 0{,}82 \times 100\%$$

$$= 82\%$$

3. Sampel C

$$\% \text{ Biodegradasi} = \frac{m_0 - m_1}{m_0} \times 100\%$$
$$= \frac{0{,}12\ g - 0{,}03\ g}{0{,}12\ g} \times 100\%$$
$$= 0{,}75 \times 100\%$$
$$= 75\%$$

4. Sampel D

$$\% \text{ Biodegradasi} = \frac{m_0 - m_1}{m_0} \times 100\%$$
$$= \frac{0{,}11\ g - 0{,}03\ g}{0{,}11\ g} \times 100\%$$
$$= 0{,}73 \times 100\%$$
$$= 73\%$$

5. Sampel E

$$\% \text{ Biodegradasi} = \frac{m_0 - m_1}{m_0} \times 100\%$$
$$= \frac{0{,}12\ g - 0{,}04\ g}{0{,}12\ g} \times 100\%$$
$$= 0{,}67 \times 100\%$$
$$= 67\%$$

➢ **Perhitungan persen selisih nilai biodegradasi**

Adapun rumus untuk menghitung penurunan persen selisih adalah sebagai berikut :

$$\% \text{ Selisih} = \frac{v_1 - v_2}{v_1} \times 100\%$$

1. Sampel A ke B

$$\% \text{ Selisih} = \frac{90\% - 82\%}{90\%} \times 100\%$$
$$= 0{,}089 \times 100\%$$
$$= 8{,}9\%$$

2. Sampel B ke C

$$\% \text{ Selisih} = \frac{82\%-75\%}{82\%} \times 100\%$$
$$= 0{,}085 \times 100\%$$
$$= 8{,}5\%$$

3. Sampel C ke D

$$\% \text{ Selisih} = \frac{75\%-72\%}{75\%} \times 100\%$$
$$= 0{,}04 \times 100\%$$
$$= 4\%$$

4. Sampel D ke E

$$\% \text{ Selisih} = \frac{72\%-67\%}{72\%} \times 100\%$$
$$= 0{,}069 \times 100\%$$
$$= 6{,}9\%$$

Lampiran 7 Data Pengujian Kuat Tarik

Sampel	F maks (N)	A_0 (mm^2)	Kuat Tarik (MPa)
A	9,47057	2,6	3,64
B	17,55359	2,6	6,75
C	21,64383	2,6	8,32
D	24,44353	2,6	9,40
E	29,21224	2,6	11,23

Data Pengujian kuat tarik sampel bioplastik didapatkan dengan menggunakan persamaan (2.3). Berikut ini merupakan perhitungan kuat tarik :

$$\sigma = F\ maks / A_0$$

Dimana :

σ = Kekuatan tarik sampel (MPa)

F maks = Beban maksimal benda yang bisa ditahan (N)

A_0 = Luas penampang awal (mm^2).

1. Sampel A

$$\sigma = \frac{F\ maks}{A}$$

$$\sigma = \frac{9,47057\ N}{2,6\ mm^2}$$

$$= 3,64\ N/mm^2 \text{ atau } 3,64\ MPa$$

2. Sampel B

$$\sigma = \frac{F\ maks}{A}$$

$$\sigma = \frac{17,55359\ N}{2,6\ mm^2}$$

$$= 6,75\ N/mm^2 \text{ atau } 6,75\ MPa$$

3. Sampel C

$$\sigma = \frac{F\ maks}{A}$$

$$\sigma = \frac{21{,}64383\ N}{2{,}6\ mm^2}$$

$$= 8{,}32\ N/mm^2 \text{ atau } 8{,}32\ MPa$$

4. Sampel D

$$\sigma = \frac{F\ maks}{A}$$

$$\sigma = \frac{24{,}44353\ N}{2{,}6\ mm^2}$$

$$= 9{,}40\ N/mm^2 \text{ atau } 9{,}40\ MPa$$

5. Sampel E

$$\sigma = \frac{F\ maks}{A}$$

$$\sigma = \frac{29{,}21224\ N}{2{,}6\ mm^2}$$

$$= 11{,}23\ N/mm^2 \text{ atau } 11{,}23\ MPa$$

➢ **Perhitungan persen selisih nilai uji kuat tarik**

Adapun rumus untuk menghitung persen selisih uji kuat tarik adalah sebagai berikut :

$$\%\ \text{Selisih} = \frac{v_2 - v_1}{v_1} \times 100\%$$

1. Sampel A ke B

$$\%\ \text{Selisih} = \frac{6{,}75\ MPa - 3{,}64\ MPa}{3{,}64\ MPa} \times 100\%$$

$$= 0{,}85 \times 100\%$$

$$= 85\%$$

2. Sampel B ke C

$$\%\ \text{Selisih} = \frac{8{,}32\ MPa - 6{,}75\ MPa}{6{,}75\ MPa} \times 100\%$$

$$= 0{,}23 \times 100\%$$

$$= 23\%$$

3. Sampel C ke D

$$\% \text{ Selisih } = \frac{9{,}40 \text{ MPa} - 8{,}32 \text{ MPa}}{8{,}32 \text{ MPa}} \times 100\%$$

$$= 0{,}13 \times 100\%$$

$$= 13\%$$

4. Sampel D ke E

$$\% \text{ Selisih } = \frac{11{,}23 \text{ MPa} - 9{,}40 \text{ MPa}}{9{,}40 \text{ MPa}} \times 100\%$$

$$= 0{,}19 \times 100\%$$

$$= 19\%$$

Lampiran 8 Data Pengujian Persen Pemanjangan

Sampel	Δl (mm)	l_0 (mm)	$\%\varepsilon$ (%)
A	20,45504	115	17,79
B	13,57806	115	11,81
C	10,82602	115	9,41
D	8,11534	115	7,06
E	4,58584	115	3,99

Data Pengujian persen pemanjangan sampel bioplastik didapatkan dengan menggunakan persamaan (2.4). Berikut ini merupakan perhitungan persen pemanjangan :

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

Dimana :

$\%\varepsilon$ = Persen Pemanjangan (%)

Δl = Pertambahan panjang (mm)

l_0 = Panjang awal material yang diukur (mm)

1. Sampel A

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

$$\%\varepsilon = \frac{20{,}45504 \text{ mm}}{115 \text{ mm}} \times 100\%$$

$$= 0{,}17787 \times 100\%$$

$$= 17{,}79\%$$

2. Sampel B

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

$$\%\varepsilon = \frac{13{,}57806 \text{ mm}}{115 \text{ mm}} \times 100\%$$

$= 0{,}11807 \times 100\%$

$= 11{,}81\%$

3. Sampel C

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

$$\%\varepsilon = \frac{10{,}82602 \text{ mm}}{115 \text{ mm}} \times 100\%$$

$= 0{,}09414 \times 100\%$

$= 9{,}41\%$

4. Sampel D

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

$$\%\varepsilon = \frac{8{,}11534 \text{ mm}}{115 \text{ mm}} \times 100\%$$

$= 0{,}07057 \times 100\%$

$= 7{,}06\%$

5. Sampel E

$$\%\varepsilon = \frac{\Delta l}{l_0} \times 100\%$$

$$\%\varepsilon = \frac{4{,}58584 \text{ mm}}{115 \text{ mm}} \times 100\%$$

$= 0{,}03988 \times 100\%$

$= 3{,}99\%$

➢ **Perhitungan persen selisih nilai persen pemanjangan**

Adapun rumus untuk menghitung penurunan persen selisih adalah sebagai berikut :

$$\%\text{ Selisih} = \frac{v_1 - v_2}{v_1} \times 100\%$$

1. Sampel A ke B

$$\%\text{ Selisih} = \frac{17{,}79\% - 11{,}81\%}{17{,}79\%} \times 100\%$$

$= 0{,}34 \times 100\%$

$= 34\%$

2. Sampel B ke C

$$\% \text{ Selisih } = \frac{11{,}81\%-9{,}41\%}{11{,}81\%} \times 100\%$$

$$= 0{,}20 \times 100\%$$

$$= 20\%$$

3. Sampel C ke D

$$\% \text{ Selisih } = \frac{9{,}41\%-7{,}06\%}{9{,}41\%} \times 100\%$$

$$= 0{,}25 \times 100\%$$

$$= 25\%$$

4. Sampel D ke E

$$\% \text{ Selisih } = \frac{7{,}06\%-3{,}99\%}{7{,}06\%} \times 100\%$$

$$= 0{,}43 \times 100\%$$

$$= 43\%$$

Lampiran 9 Data Pengujian Modulus Elastisitas

Sampel	σ (MPa)	ε	E (MPa)
A	3,64	0,17787	20,46
B	6,75	0,11807	57,17
C	8,32	0,09414	88,38
D	9,40	0,07057	133,20
E	11,23	0,03988	281,59

Data Pengujian mudulus elastisitas sampel bioplastik didapatkan dengan menggunakan persamaan (2.5). Berikut ini merupakan perhitungan modulus elastisitas :

$$E = \frac{\sigma}{\varepsilon} = \frac{F/A}{\Delta l/l_0}$$

Dimana :

E = Modulus elastisitas (MPa)

σ = Kuat tarik/tegangan (MPa)

ε = Pemanjangan saat putus/regangan

1. Sampel A

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{3,64\ MPa}{0,17787}$$

$$= 20,46\ MPa$$

2. Sampel B

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{6,75\ MPa}{0,11807}$$

$$= 57,17\ MPa$$

3. Sampel C

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{8{,}32\ \text{MPa}}{0{,}09414}$$

$$= 88{,}38\ \text{MPa}$$

4. Sampel D

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{9{,}40\ \text{MPa}}{0{,}07057}$$

$$= 133{,}20\ \text{MPa}$$

5. Sampel E

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{11{,}23\ \text{MPa}}{0{,}03988}$$

$$= 281{,}59\ \text{MPa}$$

➢ **Perhitungan persen selisih nilai modulus elastisitas**

Adapun rumus untuk menghitung persen selisih antar sampel adalah sebagai berikut :

$$\%\ \text{Selisih} = \frac{v_2 - v_1}{v_1} \times 100\%$$

1. Sampel A ke B

$$\%\ \text{Selisih} = \frac{57{,}17\ \text{MPa} - 20{,}46\ \text{MPa}}{20{,}46\ \text{MPa}} \times 100\%$$

$$= 1{,}79 \times 100\%$$

$$= 1$$

2. Sampel B ke C

$$\% \text{ Selisih} = \frac{88{,}38 \text{ MPa} - 57{,}17 \text{ MPa}}{57{,}17 \text{ MPa}} \times 100\%$$

$$= 0{,}55 \times 100\%$$

$$= 55\%$$

3. Sampel C ke D

$$\% \text{ Selisih} = \frac{133{,}20 \text{ MPa} - 88{,}38 \text{ MPa}}{88{,}38 \text{ MPa}} \times 100\%$$

$$= 0{,}51 \times 100\%$$

$$= 51\%$$

4. Sampel D ke E

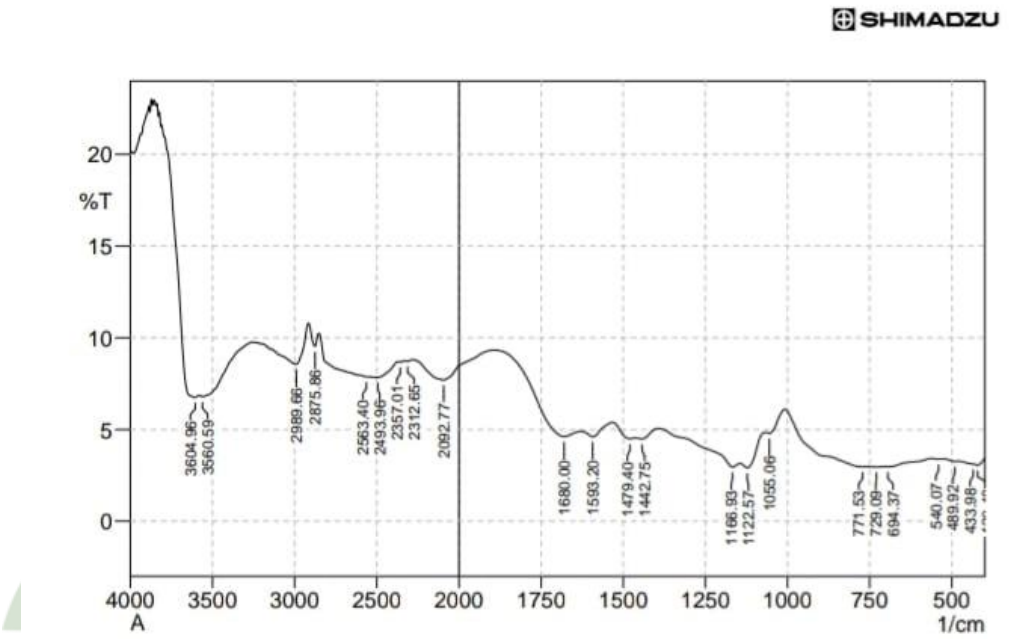
$$\% \text{ Selisih} = \frac{281{,}84 \text{ MPa} - 133{,}20 \text{ MPa}}{133{,}20 \text{ MPa}} \times 100\%$$

$$= 1{,}12 \times 100\%$$

$$= 111\%$$

Lampiran 10 Analisa FTIR

1. Sampel A dengan komposisi pati (100%) : Selulosa (0%)

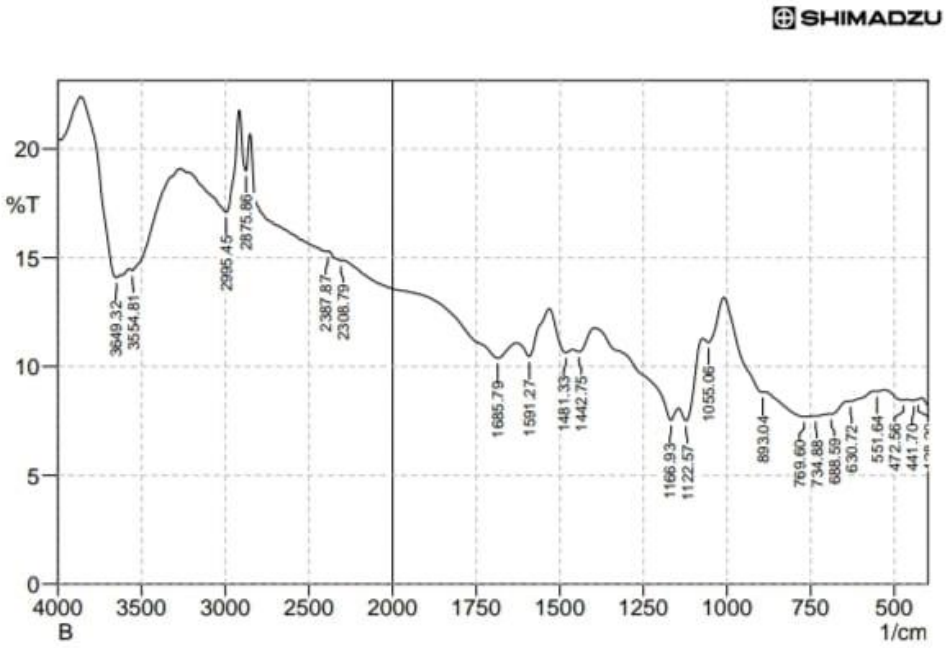


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	420.48	3.05	0.144	428.2	399.26	43.344	0.398
2	433.98	3.104	0.019	443.63	430.13	20.34	0.026
3	489.92	3.256	0.041	516.92	482.2	51.443	0.118
4	540.07	3.383	0.018	559.36	532.35	39.682	0.045
5	694.37	2.969	0.014	698.23	561.29	204.953	0.219
6	729.09	2.951	0.02	752.24	707.88	67.806	0.058
7	771.53	2.967	0.08	1006.84	765.74	343.387	12.581
8	1055.06	4.79	0.3	1066.64	1008.77	73.848	0.789
9	1122.57	2.906	0.68	1141.86	1068.56	105.791	2.891
10	1166.93	2.957	0.362	1392.61	1143.79	347.177	1.235
11	1442.75	4.489	0.179	1460.11	1394.53	87.018	0.514
12	1479.4	4.497	0.248	1531.48	1462.04	91.759	1.005
13	1593.2	4.599	0.486	1629.85	1533.41	126.059	1.772
14	1680	4.617	1.107	1890.24	1631.78	306.797	7.235
15	2092.77	7.694	0.258	2121.7	1892.17	246.823	1.436
16	2312.65	8.716	0.046	2331.94	2279.86	55.093	0.051
17	2357.01	8.677	0.036	2368.59	2333.87	36.821	0.039
18	2493.96	7.837	0.061	2501.67	2370.51	142.634	0.672
19	2563.4	7.869	0.031	2600.04	2549.89	55.282	0.044
20	2875.86	9.533	0.893	2914.44	2854.65	59.843	1.299
21	2989.66	8.558	0.058	2991.59	2916.37	77.21	0.817
22	3560.59	6.784	0.071	3577.95	3539.38	45	0.099
23	3604.96	6.746	1.713	3809.41	3579.88	217.559	10.629

Comment;
A

Date/Time; 12/28/2021 6:02:01 PM
No. of Scans;
Resolution;
Apodization;

2. Sampel B dengan komposisi pati (87,5%) : Selulosa (12,5%)

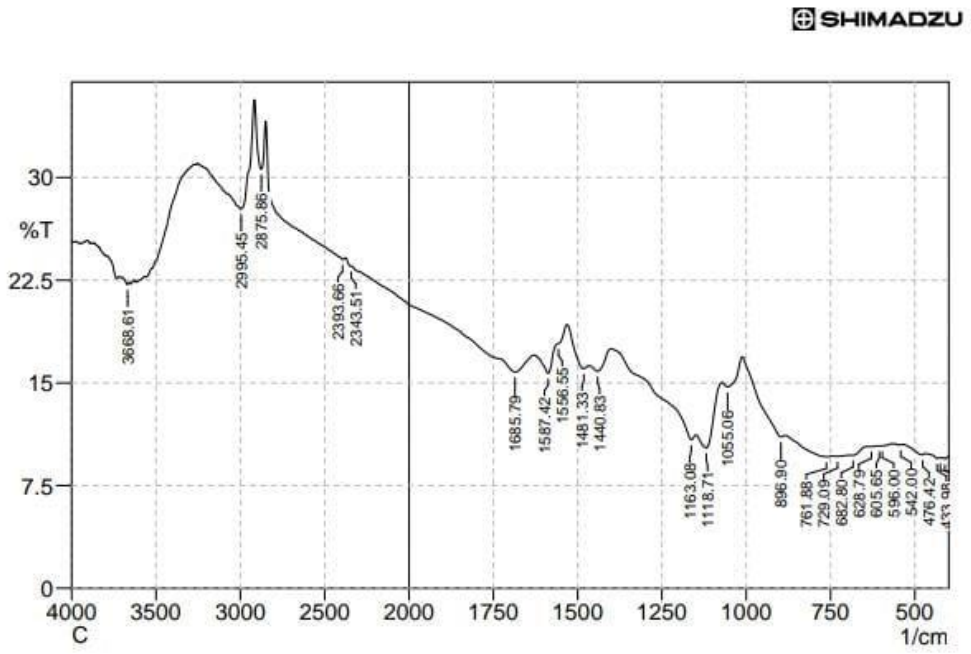


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	428.2	8.48	0.029	432.05	418.55	14.443	0.008
2	441.7	8.428	0.057	459.06	433.98	26.902	0.037
3	472.56	8.456	0.046	526.57	468.7	61.536	0.153
4	551.64	8.856	0.029	561.29	528.5	34.477	0.025
5	630.72	8.402	0.014	632.65	563.21	74.017	0.168
6	688.59	7.811	0.081	696.3	634.58	67.382	0.152
7	734.88	7.72	0.016	740.67	698.23	47.105	0.027
8	769.6	7.689	0.245	883.4	742.59	153.88	1.301
9	893.04	8.814	0.282	1008.77	885.33	121.733	2.219
10	1055.06	11.104	0.712	1072.42	1010.7	57.297	0.96
11	1122.57	7.502	1.551	1143.79	1074.35	73.338	2.687
12	1166.93	7.534	0.854	1394.53	1145.72	251.721	1.204
13	1442.75	10.677	0.374	1460.11	1396.46	60.781	0.48
14	1481.33	10.638	0.677	1529.55	1462.04	64.155	1.131
15	1591.27	10.463	1.213	1627.92	1531.48	91.145	1.838
16	1685.79	10.381	1.014	2291.43	1629.85	587.58	3.394
17	2308.79	14.863	0.084	2380.16	2293.36	71.53	0.211
18	2387.87	15.281	0.031	2546.04	2382.09	132.698	0.19
19	2875.86	18.998	2.089	2916.37	2852.72	44.537	1.673
20	2995.45	17.087	3.957	3221.12	2918.3	224.046	14.392
21	3554.81	14.411	0.366	3572.17	3323.35	196.238	1.819
22	3649.32	14.081	1.162	3861.49	3618.46	182.599	2.589

Comment;
B

Date/Time; 12/28/2021 6:00:40 PM
No. of Scans;
Resolution;
Apodization;

3. Sampel C dengan komposisi pati (75%:) : Selulosa (25%)

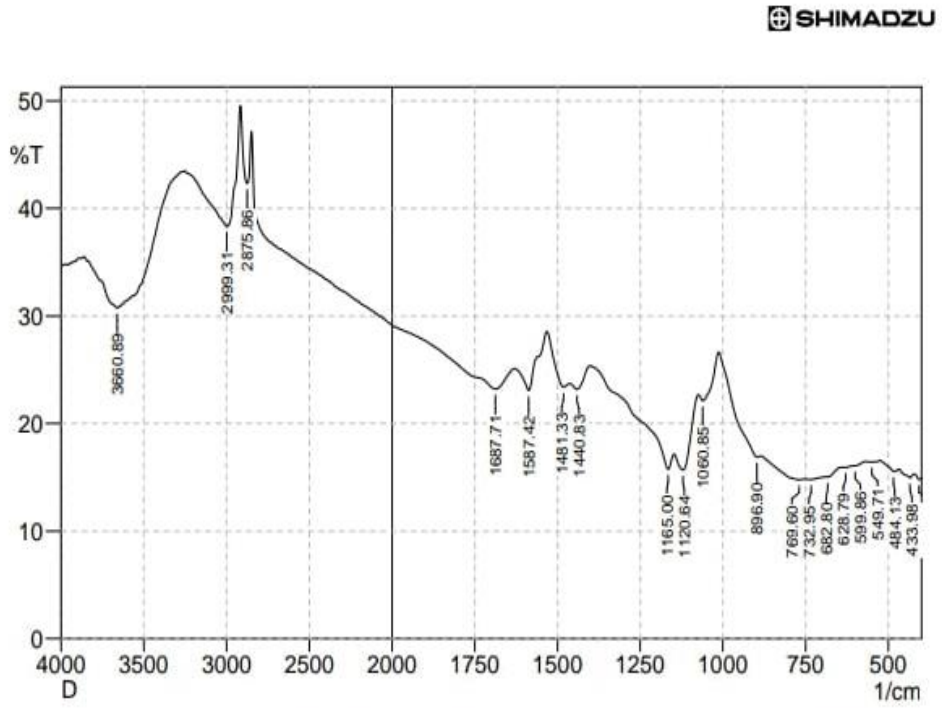


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	410.84	9.447	0.129	416.62	399.26	17.72	0.057
2	424.34	9.501	0.019	428.2	418.55	9.851	0.004
3	433.98	9.482	0.062	468.7	430.13	39.11	0.017
4	476.42	9.745	0.163	534.28	470.63	63.424	0.236
5	542	10.472	0.017	545.85	536.21	9.446	0.004
6	596	10.401	0.01	597.93	569	28.36	0.02
7	605.65	10.388	0.014	613.36	599.86	13.274	0.004
8	628.79	10.342	0.038	642.3	615.29	26.588	0.023
9	682.8	9.709	0.118	690.52	644.22	46.324	0.139
10	729.09	9.628	0.051	744.52	692.44	52.842	0.057
11	761.88	9.604	0.228	883.4	746.45	136.075	1.335
12	896.9	11.062	0.635	1010.7	885.33	110.264	2.039
13	1055.06	14.698	0.828	1070.49	1012.63	47.182	1.081
14	1118.71	10.254	2.419	1147.65	1072.42	69.664	3.12
15	1163.08	10.852	0.687	1400.32	1149.57	212.06	0.444
16	1440.83	15.854	0.862	1463.97	1402.25	48.454	0.768
17	1481.33	16.049	0.909	1531.48	1465.9	50.444	1.049
18	1556.55	17.866	0.106	1558.48	1533.41	18.422	0.102
19	1587.42	15.704	1.822	1627.92	1560.41	52.608	1.421
20	1685.79	15.794	1.097	1734.01	1629.85	81.918	1.505
21	2343.51	23.525	0.034	2376.3	2341.58	21.681	0.045
22	2393.66	24.01	0.217	2501.67	2378.23	75.558	0.234
23	2875.86	30.62	4.079	2916.37	2850.79	32.376	2.356
24	2995.45	27.726	1.875	3016.67	2918.3	51.76	2.594
25	3668.61	22.189	0.266	3695.61	3657.04	25.09	0.106

Comment;
C

Date/Time; 12/28/2021 6:03:51 PM
No. of Scans;
Resolution;
Apodization;

4. Sampel D dengan komposisi pati (62,5%) : Selulosa (37,5%)

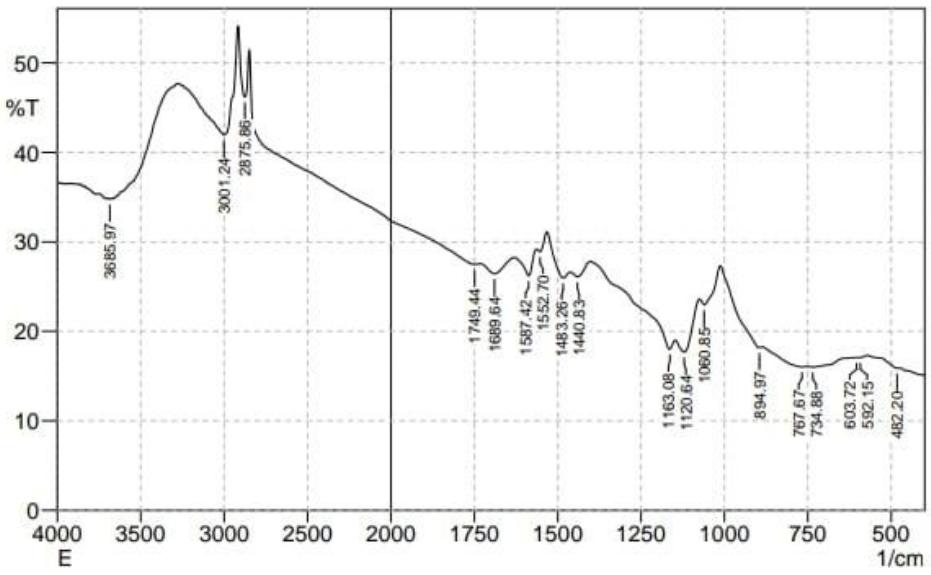


No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	406.98	14.787	0.266	420.48	399.26	17.503	0.075
2	433.98	14.959	0.452	466.77	422.41	36.255	0.345
3	484.13	15.541	0.425	524.64	468.7	44.597	0.272
4	549.71	16.42	0.074	565.14	526.57	30.237	0.052
5	599.86	16.075	0.022	601.79	567.07	27.377	0.021
6	628.79	15.913	0.063	640.37	601.79	30.719	0.027
7	682.8	15.029	0.118	688.59	642.3	37.552	0.089
8	732.95	14.802	0.084	748.38	690.52	47.849	0.066
9	769.6	14.77	0.288	883.4	756.1	102.903	1.074
10	896.9	16.879	0.992	1010.7	885.33	87.123	2.612
11	1060.85	22.122	1.307	1072.42	1012.63	37.543	1.162
12	1120.64	15.679	3.398	1145.72	1074.35	53.258	3.053
13	1165	15.756	1.966	1400.32	1147.65	172.353	1.226
14	1440.83	23.191	1.106	1462.04	1402.25	37.106	0.638
15	1481.33	23.388	1.565	1531.48	1463.97	40.716	1.17
16	1587.42	23.073	3.541	1629.85	1533.41	57.734	2.583
17	1687.71	23.199	2.49	2673.34	1631.78	543.159	5.577
18	2875.86	42.35	5.714	2916.37	2850.79	23.141	2.414
19	2999.31	38.346	9.71	3251.98	2918.3	128.493	17.291
20	3660.89	30.746	6.94	3834.49	3277.06	254.299	26.648

Comment;
D

Date/Time; 1/4/2022 9:45:23 AM
No. of Scans;
Resolution;
Apodization;

5. Sampel E dengan komposisi pati (50%) : Selulosa (50%)



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	482.2	15.866	0.11	569	476.42	72.037	0.044
2	592.15	17.075	0.023	594.08	570.93	17.703	0.016
3	603.72	17.066	0.003	605.65	596	7.405	0.001
4	734.88	16.016	0.16	750.31	607.58	111.731	0.427
5	767.67	16.022	0.302	883.4	752.24	101.6	1.024
6	894.97	18.181	0.77	1010.7	885.33	84.006	2.189
7	1060.85	22.988	1.433	1074.35	1012.63	37.869	1.192
8	1120.64	17.698	2.951	1145.72	1076.28	49.222	2.484
9	1163.08	18.012	1.532	1402.25	1147.65	161.898	0.774
10	1440.83	26.099	0.914	1460.11	1404.18	32.074	0.457
11	1483.26	25.967	2.002	1531.48	1462.04	39.037	1.381
12	1552.7	28.908	0.811	1560.41	1533.41	14.246	0.199
13	1587.42	26.208	2.606	1629.85	1562.34	37.757	1.168
14	1689.64	26.454	1.392	1732.08	1631.78	56.729	1.129
15	1749.44	27.493	0.391	2848.86	1734.01	505.374	33.13
16	2875.86	46.207	6.247	2916.37	2850.79	20.642	2.406
17	3001.24	41.999	10.449	3251.98	2918.3	115.814	17.391
18	3685.97	34.766	0.104	3693.68	3670.54	10.606	0.016

Comment;
E

Date/Time: 1/4/2022 9:43:20 AM
No. of Scans;
Resolution;
Apodization;

Lampiran 11 ASTM D570-98

Designation: D570 – 98 (Reapproved 2010)$^{\varepsilon 1}$

Standard Test Method for Water Absorption of Plastics[1]

This standard is issued under the fixed designation D570; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε^1 NOTE—Removed ASTM D647 as a referenced document editorially in June 2010.

1. Scope

1.1 This test method covers the determination of the relative rate of absorption of water by plastics when immersed. This test method is intended to apply to the testing of all types of plastics, including cast, hot-molded, and cold-molded resinous products, and both homogeneous and laminated plastics in rod and tube form and in sheets 0.13 mm (0.005 in.) or greater in thickness.

1.2 The values given in SI units are to be regarded as standard. The values stated in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This standard is equivalent to ISO 62.

2. Referenced Documents

2.1 *ISO Standard:*
ISO 62 Plastics—Determination of Water Absorption[2]

3. Significance and Use

3.1 This test method for rate of water absorption has two chief functions: first, as a guide to the proportion of water absorbed by a material and consequently, in those cases where the relationships between moisture and electrical or mechanical properties, dimensions, or appearance have been determined, as a guide to the effects of exposure to water or humid conditions on such properties; and second, as a control test on the uniformity of a product. This second function is particularly applicable to sheet, rod, and tube arms when the test is made on the finished product.

3.2 Comparison of water absorption values of various plastics can be made on the basis of values obtained in accordance with 7.1 and 7.4.

3.3 Ideal diffusion of liquids[3] into polymers is a function of the square root of immersion time. Time to saturation is strongly dependent on specimen thickness. For example, Table 1 shows the time to approximate time saturation for various thickness of nylon-6.

3.4 The moisture content of a plastic is very intimately related to such properties as electrical insulation resistance, dielectric losses, mechanical strength, appearance, and dimensions. The effect upon these properties of change in moisture content due to water absorption depends largely on the type of exposure (by immersion in water or by exposure to high humidity), shape of the part, and inherent properties of the plastic. With nonhomogeneous materials, such as laminated forms, the rate of water absorption may be widely different through each edge and surface. Even for otherwise homogeneous materials, it may be slightly greater through cut edges than through molded surfaces. Consequently, attempts to correlate water absorption with the surface area must generally be limited to closely related materials and to similarly shaped specimens: For materials of widely varying density, relation between water-absorption values on a volume as well as a weight basis may need to be considered.

4. Apparatus

4.1 *Balance*—An analytical balance capable of reading 0.0001 g.

4.2 *Oven,* capable of maintaining uniform temperatures of 50 ± 3°C (122 ± 5.4°F) and of 105 to 110°C (221 to 230°F).

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Durability of Plastics.
Current edition approved April 1, 2010. Published June 2010. Originally approved in 1940. Last previous edition approved in 2005 as D570 - 98 (2005). DOI: 10.1520/D0570-98R10E01.

[2] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[3] Additional information regarding diffusion of liquids in polymers can be found in the following references: (*1*) *Diffusion, Mass Transfer in Fluid Systems,* E. L. Cussler, Cambridge University Press, 1985, ISBN 0-521-29846-6, (*2*) *Diffusion in Polymers,* J. Crank and G. S. Park, Academic Press, 1968, and (*3*) "Permeation, Diffusion, and Sorption of Gases and Vapors," R. M. Felder and G. S. Huvard, in *Methods of Experimental Physics,* Vol 16C, 1980, Academic Press.

TABLE 1 Time to Saturation for Various Thickness of Nylon-6

Thickness, mm	Typical Time to 95 % Saturation, h
1	100
2	400
3.2	1 000
10	10 000
25	62 000

5. Test Specimen

5.1 The test specimen for molded plastics shall be in the form of a disk 50.8 mm (2 in.) in diameter and 3.2 mm (⅛ in.) in thickness. Permissible variations in thickness are ±0.18 mm (±0.007 in.) for hot-molded and ±0.30 mm (±0.012 in.) for cold-molded or cast materials.

5.2 *ISO Standard Specimen*—The test specimen for homogeneous plastics shall be 60 by 60 by 1 mm. Tolerance for the 60-mm dimension is ±2 mm and ±0.05 mm for the 1-mm thickness. This test method and ISO 62 are technically equivalent when the test specimen described in 5.2 is used.

5.3 The test specimen for sheets shall be in the form of a bar 76.2 mm (3 in.) long by 25.4 mm (1 in.) wide by the thickness of the material. When comparison of absorption values with molded plastics is desired, specimens 3.2-mm (⅛-in.) thick should be used. Permissible variations in thickness shall be 0.20 mm (±0.008 in.) except for materials which have greater standard commercial tolerances.

5.4 The test specimen for rods shall be 25.4-mm (1-in.) long for rods 25.4 mm in diameter or under and 12.7-mm (½-in.) long for larger-diameter rods. The diameter of the specimen shall be the diameter of the finished rod.

5.5 The test specimen for tubes less than 76 mm (3 in.) in inside diameter shall be the full section of the tube and 25.4-mm (1-in.) long. For tubes 76 mm (3 in.) or more in inside diameter, a rectangular specimen shall be cut 76 mm in length in the circumferential direction of the tube and 25.4 mm in width lengthwise of the tube.

5.6 The test specimens for sheets, rods, and tubes shall be machined, sawed, or sheared from the sample so as to have smooth edges free from cracks. The cut edges shall be made smooth by finishing with No. 0 or finer sandpaper or emery cloth. Sawing, machining, and sandpapering operations shall be slow enough so that the material is not heated appreciably.

NOTE 2—If there is any oil on the surface of the specimen when received or as a result of machining operations, wash the specimen with a cloth wet with gasoline to remove oil, wipe with a dry cloth, and allow to stand in air for 2 h to permit evaporation of the gasoline. If gasoline attacks the plastic, use some suitable solvent or detergent that will evaporate within the 2-h period.

5.7 The dimensions listed in the following table for the various specimens shall be measured to the nearest 0.025 mm (0.001 in.). Dimensions not listed shall be measured within 0.8 mm (±1/32 in.).

Type of Specimen	Dimensions to Be Measured to the Nearest 0.025 mm (0.001 in.)
Molded disk	thickness
Sheet	thickness
Rod	length and diameter
Tube	inside and outside diameter, and wall thickness

6. Conditioning

6.1 Three specimens shall be conditioned as follows:

6.1.1 Specimens of materials whose water-absorption value would be appreciably affected by temperatures in the neighborhood of 110°C (230°F), shall be dried in an oven for 24 h at 50 ± 3°C (122 ± 5.4°F), cooled in a desiccator, and immediately weighed to the nearest 0.001 g.

NOTE 3—If a static charge interferes with the weighing, lightly rub the surface of the specimens with a grounded conductor.

6.1.2 Specimens of materials, such as phenolic laminated plastics and other products whose water-absorption value has been shown not to be appreciably affected by temperatures up to 110°C (230°F), shall be dried in an oven for 1 h at 105 to 110°C (221 to 230°F).

6.1.3 When data for comparison with absorption values for other plastics are desired, the specimens shall be dried in an oven for 24 h at 50 ± 3°C (122 ± 5.4°F), cooled in a desiccator, and immediately weighed to the nearest 0.001 g.

7. Procedure

7.1 *Twenty-Four Hour Immersion*—The conditioned specimens shall be placed in a container of distilled water maintained at a temperature of 23 ± 1°C (73.4 ± 1.8°F), and shall rest on edge and be entirely immersed. At the end of 24, +½, –0 h, the specimens shall be removed from the water one at a time, all surface water wiped off with a dry cloth, and weighed to the nearest 0.001 g immediately. If the specimen is 1/16 in. or less in thickness, it shall be put in a weighing bottle immediately after wiping and weighed in the bottle.

7.2 *Two-Hour Immersion*—For all thicknesses of materials having a relatively high rate of absorption, and for thin specimens of other materials which may show a significant weight increase in 2 h, the specimens shall be tested as described in 7.1 except that the time of immersion shall be reduced to 120 ± 4 min.

7.3 *Repeated Immersion*—A specimen may be weighed to the nearest 0.001 g after 2-h immersion, replaced in the water, and weighed again after 24 h.

NOTE 4—In using this test method the amount of water absorbed in 24 h may be less than it would have been had the immersion not been interrupted.

7.4 *Long-Term Immersion*—To determine the total water absorbed when substantially saturated, the conditioned specimens shall be tested as described in 7.1 except that at the end of 24 h they shall be removed from the water, wiped free of surface moisture with a dry cloth, weighed to the nearest 0.001 g immediately, and then replaced in the water. The weighings shall be repeated at the end of the first week and every two weeks thereafter until the increase in weight per two-week period, as shown by three consecutive weighings, averages less

than 1 % of the total increase in weight or 5 mg, whichever is greater; the specimen shall then be considered substantially saturated. The difference between the substantially saturated weight and the dry weight shall be considered as the water absorbed when substantially saturated.

7.5 *Two-Hour Boiling Water Immersion*—The conditioned specimens shall be placed in a container of boiling distilled water, and shall be supported on edge and be entirely immersed. At the end of 120 ± 4 min, the specimens shall be removed from the water and cooled in distilled water maintained at room temperature. After 15 ± 1 min, the specimens shall be removed from the water, one at a time, all surface water removed with a dry cloth, and the specimens weighed to the nearest 0.001 g immediately. If the specimen is 1/16 in. or less in thickness, it shall be weighed in a weighing bottle.

7.6 *One-Half-Hour Boiling Water Immersion*—For all thicknesses of materials having a relatively high rate of absorption and for thin specimens of other materials which may show a significant weight increase in ½ h, the specimens shall be tested as described in 7.5, except that the time of immersion shall be reduced to 30 ± 1 min.

7.7 *Immersion at 50°C*—The conditioned specimens shall be tested as described in 7.5, except that the time and temperature of immersion shall be 48 ± 1 h and 50 ± 1°C (122.0 ± 1.8°F), respectively, and cooling in water before weighing shall be omitted.

7.8 When data for comparison with absorption values for other plastics are desired, the 24-h immersion procedure described in 7.1 and the equilibrium value determined in 7.4 shall be used.

8. Reconditioning

8.1 When materials are known or suspected to contain any appreciable amount of water-soluble ingredients, the specimens, after immersion, shall be weighed, and then reconditioned for the same time and temperature as used in the original drying period. They shall then be cooled in a desiccator and immediately reweighed. If the reconditioned weight is lower than the conditioned weight, the difference shall be considered as water-soluble matter lost during the immersion test. For such materials, the water-absorption value shall be taken as the sum of the increase in weight on immersion and of the weight of the water-soluble matter.

9. Calculation and Report

9.1 The report shall include the values for each specimen and the average for the three specimens as follows:

9.1.1 Dimensions of the specimens before test, measured in accordance with 5.6, and reported to the nearest 0.025 mm (0.001 in.),

9.1.2 Conditioning time and temperature,

9.1.3 Immersion procedure used,

9.1.4 Time of immersion (long-term immersion procedure only),

9.1.5 Percentage increase in weight during immersion, calculated to the nearest 0.01 % as follows:

$$\text{Increase in weight, \%} = \frac{\text{wet weight} - \text{conditioned weight}}{\text{conditioned weight}} \times 100$$

9.1.6 Percentage of soluble matter lost during immersion, if determined, calculated to the nearest 0.01 % as follows (see Note 5):

$$\text{Soluble matter lost, \%} = \frac{\text{conditioned weight} - \text{reconditioned weight}}{\text{conditioned weight}} \times 100$$

NOTE 5—When the weight on reconditioning the specimen after immersion in water exceeds the conditioned weight prior to immersion, report "none" under 9.1.6.

9.1.7 For long-term immersion procedure only, prepare a graph of the increase in weight as a function of the square root of each immersion time. The initial slope of this graph is proportional to the diffusion constant of water in the plastic. The plateau region with little or no change in weight as a function of the square root of immersion time represents the saturation water content of the plastic.

NOTE 6—Deviation from the initial slope and plateau model indicates that simple diffusion may be a poor model for determining water content. In such cases, additional studies are suggested to determine a better model for water absorption.

9.1.8 The percentage of water absorbed, which is the sum of the values in 9.1.5 and 9.1.6, and

9.1.9 Any observations as to warping, cracking, or change in appearance of the specimens.

10. Precision and Bias[4]

10.1 *Precision*—An interlaboratory test program was carried out using the procedure outlined in 7.1, involving three laboratories and three materials. Analysis of this data yields the following coefficients of variation (average of three replicates).

	Within Laboratories	Between Laboratories
Average absorption above 1 % (2 materials)	2.33 %	4.89 %
Average absorption below 0.2 % (1 material)	9.01 %	16.63 %

NOTE 7—A round robin is currently under way to more completely determine repeatability and reproducibility of this test method.

10.2 *Bias*—No justifiable statement on the bias of this test method can be made, since the true value of the property cannot be established by an accepted referee method.

11. Keywords

11.1 absorption; immersion; plastics; water

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1064.

Lampiran 12 ASTM D882-12

Designation: D882 – 12

Standard Test Method for Tensile Properties of Thin Plastic Sheeting[1]

This standard is issued under the fixed designation D882; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.
These test methods have been approved for use by agencies of the Department of Defense to replace Method 1013 of Federal Test Method Standard 406.

1. Scope*

1.1 This test method covers the determination of tensile properties of plastics in the form of thin sheeting and films (less than 1.0 mm (0.04 in.) in thickness).

NOTE 1—Film is defined in Terminology D883 as an optional term for sheeting having a nominal thickness no greater than 0.25 mm (0.010 in.).
NOTE 2—Tensile properties of plastics 1.0 mm (0.04 in.) or greater in thickness shall be determined according to Test Method D638.

1.2 This test method can be used to test all plastics within the thickness range described and the capacity of the machine employed.

1.3 Specimen extension can be measured by grip separation, extension indicators, or displacement of gage marks.

1.4 The procedure for determining the tensile modulus of elasticity is included at one strain rate.

NOTE 3—The modulus determination is generally based on the use of grip separation as a measure of extension; however, the desirability of using extensometers, as described in 5.2, is recognized and provision for the use of such instrumentation is incorporated in the procedure.

1.5 Test data obtained by this test method is relevant and appropriate for use in engineering design.

1.6 The values stated in SI units are to be regarded as the standard. The values in parentheses are provided for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 4—This test method is similar to ISO 527-3, but is not considered technically equivalent. ISO 527-3 allows for additional specimen configurations, specifies different test speeds, and requires an extensometer or gage marks on the specimen.

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D883 Terminology Relating to Plastics
D4000 Classification System for Specifying Plastic Materials
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
D6287 Practice for Cutting Film and Sheeting Test Specimens
D6988 Guide for Determination of Thickness of Plastic Film Test Specimens
E4 Practices for Force Verification of Testing Machines
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ISO Standard:*
ISO 527-3 Plastics—Determination of Tensile Properties—Part 3: Test Conditions for Films and Sheets[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms and symbols relating to tension testing of plastics appear in the Annex to Test Method D638.

3.1.2 *line grips*—grips having faces designed to concentrate the entire gripping force along a single line perpendicular to the direction of testing stress. This is usually done by combining one standard flat face and an opposing face from which protrudes a half-round.

3.1.3 *flat grips*—grips having flat faces and lined with thin rubber, crocus-cloth, emery cloth, or pressure-sensitive tape.

3.1.4 *tear failure*—a tensile failure characterized by fracture initiating at one edge of the specimen and progressing across

[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.
Current edition approved Aug. 1, 2012. Published September 2012. Originally approved in 1946. Last previous edition approved in 2010 as D882 - 10. DOI: 10.1520/D0882-12.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

11.9 *Secant Modulus,* at a designated strain, shall be calculated by dividing the corresponding stress (nominal) by the designated strain. Elastic modulus values are preferable and shall be calculated whenever possible. However, for materials where no proportionality is evident, the secant modulus values shall be calculated. Draw the tangent as directed in A1.3 and Fig. A1.2 of Annex A1, and mark off the designated strain from the yield point where the tangent line goes through zero stress. The stress to be used in the calculation is then determined by dividing the load at the designated strain on the load-extension curve by the original average cross-sectional area of the specimen.

11.10 *Tensile Energy to Break,* where applicable, shall be calculated by integrating the energy per unit volume under the stress-strain curve or by integrating the total energy absorbed and dividing it by the volume of the original gage region of the specimen. As indicated in Annex A2, this shall be done directly during the test by an electronic integrator, or subsequently by computation from the area of the plotted curve. The result shall be expressed in energy per unit volume, usually in megajoules per cubic metre (or inch-pounds-force per cubic inch). This value shall be reported to two significant figures.

11.11 For each series of tests, the arithmetic mean of all values obtained shall be calculated to the proper number of significant figures.

11.12 The standard deviation (estimated) shall be calculated as follows and reported to two significant figures:

$$s = \sqrt{\left(\sum X^2 - n\,\bar{X}^2\right)/(n-1)} \qquad (2)$$

where:

s = estimated standard deviation,
X = value of a single observation,
n = number of observations, and
$\bar{X}$ = arithmetic mean of the set of observations.

12. Report

12.1 Report the following information:

12.1.1 Complete identification of the material tested, including type, source, manufacturer's code number, form, principal dimensions, previous history, and orientation of samples with respect to anisotropy (if any),

12.1.2 Method of preparing test specimens,

12.1.3 Thickness, width, and length of test specimens,

12.1.4 Number of specimens tested,

12.1.5 Strain rate employed,

12.1.6 Grip separation (initial),

12.1.7 Crosshead speed (rate of grip separation),

12.1.8 Gage length (if different from grip separation),

12.1.9 Type of grips used, including facing (if any),

12.1.10 Conditioning procedure (test conditions, temperature, and relative humidity if nonstandard),

12.1.11 Anomalous behavior such as tear failure and failure at a grip,

12.1.12 Average breaking factor and standard deviation,

12.1.13 Average tensile strength (nominal) and standard deviation,

12.1.14 Average tensile strength at break (nominal) and standard deviation,

12.1.15 Average percent elongation at break and standard deviation,

12.1.16 Where applicable, average tensile energy to break and standard deviation,

12.1.17 In the case of materials exhibiting "yield" phenomenon: average yield strength and standard deviation; and average percent elongation at yield and standard deviation,

12.1.18 For materials which do not exhibit a yield point: average —% offset yield strength and standard deviation; and average percent elongation at —% offset yield strength and standard deviation,

12.1.19 Average modulus of elasticity and standard deviation (if secant modulus is used, so indicate and report strain at which calculated), and

12.1.20 When an extensometer is employed, so indicate.

13. Precision and Bias

13.1 Two interlaboratory tests have been run for these tensile properties. The first was run for modulus only, in 1977, in which randomly drawn samples of four thin (~0.025 mm (0.001-in.)) materials were tested with five specimens in each laboratory. Elastic (tangent) modulus measurements were made by six laboratories, and secant (1 %) modulus measurements were taken by five laboratories. The relative precision obtained in this interlaboratory study is in Table 2.

13.1.1 In deriving the estimates in Table 2, statistical outliers were not removed, in keeping with Practice E691.[5]

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1084.

TABLE 2 Precision Data for Modulus

Material	Thickness, mils	Average, 10^3 psi	S_r, 10^3 psi	S_R, 10^3 psi	I_r, 10^3 psi	I_R, 10^3 psi
Tangent Modulus						
LDPE	1.4	53.9	1.81	8.81	5.12	24.9
HDPE	1.6	191	5.47	16.2	15.5	45.9
PP	1.1	425	10.3	31.5	29.0	89.1
PET	0.9	672	13.8	55.5	39.1	157.1
Secant Modulus						
LDPE	1.4	45.0	2.11	3.43	5.98	9.70
HDPE	1.6	150	3.29	9.58	9.30	27.1
PP	1.1	372	4.66	26.5	13.2	74.9
PET	0.9	640	10.0	27.5	28.4	77.8

13.1.2 The within-lab standard deviation of a mean value, $S_{\bar{x}}$, in each case was determined from the standard deviation, S_x, of the five individual specimens as follows: $S_{\bar{x}} = S_x/(5)^{1/2}$. The $S_{\bar{x}}$ values were pooled among laboratories for a given material to obtain the within-lab standard deviation, S_r, of a test result (mean of five specimens). See 13.3 – 13.3.2 for definitions of terms in the tables.

13.2 An interlaboratory test was run for all the other tensile properties except modulus in 1981, in which randomly drawn samples of six materials (one of these in three thicknesses) ranging in thickness from 0.019 to 0.178 mm (0.00075 to 0.007 in.) were tested in seven laboratories. A test result was defined as the mean of five specimen determinations. However, each laboratory tested eight specimens, and the $S_{\bar{x}}$ was determined from $S_{\bar{x}} = S_x/(5)^{1/2}$ as above. This was done to improve the quality of the statistics while maintaining their applicability to a five-specimen test result. The materials and their thicknesses are identified in Tables 3-7, each of which contain data for one of the following properties: tensile yield strength, yield elongation, tensile strength, tensile elongation at break, and tensile energy at break (see Note 20).[6]

NOTE 20—Subsequent to filing the research report, examination of the LDPE used in this study between crossed polarizers revealed lengthwise lines representing substantial widthwise variation in molecular orientation that probably was not successfully randomized out of the between-labs component of variance.

13.3 For the purpose of compiling summary statistics, a test result has been defined to be the average of five replicate measurements of a property for a material in a laboratory, as specified in this test method. Summary statistics are given in Table 3. In each table, for the material indicated, *S(r)* is the pooled within-laboratory standard deviation of a test result, *S(R)* is the between-laboratory standard deviation of a test result, where *r* equals 2.83 × *S(r)* (see 13.3.1) and *R* equals 2.83 × *S(R)* (see 13.3.2). (**Warning—**The following explanations of I_r and I_R (13.3 – 13.3.3) are only intended to present a meaningful way of considering the *Approximate* precision of this test method. The data in Table 2 should not be rigorously applied to the acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles of 13.3 – 13.3.3 would then be valid for such data.)

13.3.1 *Repeatability*, I_r (Comparing two test results for the same material, obtained by the same operator using the same equipment on the same day)—The two test results shall be judged not equivalent if they differ by more than the I_r value for that material.

13.3.2 *Reproducibility*—In comparing two mean values for the same material obtained by different operators using different equipment on different days, either in the same laboratory or in different laboratories, the means shall be judged not equivalent if they differ by more than the *R* value for that material.

13.3.3 Any judgment made in accordance with 13.3.1 and 13.3.2 shall have an approximate 95 % (0.95) probability of being correct.

13.3.4 For further information, see Practice E691.

13.4 *Bias*—The systematic error which contributes to the difference between a test result and a true (or reference) value. There are no recognized standards on which to base an estimate of bias for these test methods.

14. Keywords

14.1 modulus of elasticity; plastic film; plastic sheeting; tensile properties; tensile strength; toughness; yield stress

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1101.

TABLE 3 Precision Data for Yield Stress

Material	Thickness, mils	Average, 10^3 psi	$(S_r)^A$ 10^3 psi	$(S_R)^B$ 10^3 psi	$I(r)^C$ 10^3 psi	$I(R)^D$ 10^3 psi
LDPE	1.0	1.49	0.051	0.13	0.14	0.37
HDPE	1.0	4.33	0.084	0.16	0.24	0.44
PP	0.75	6.40	0.13	0.52	0.37	1.46
PC	4.0	8.59	0.072	0.29	0.20	0.82
CTA	5.3	11.4	0.12	0.50	0.34	1.43
PET	4.0	14.3	0.12	0.23	0.34	0.66
PET	2.5	14.4	0.14	0.54	0.40	1.52
PET	7.0	14.4	0.13	0.36	0.37	1.03

[A] S_r is the within-laboratory standard deviation of the average.
[B] S_R is the between-laboratories standard deviation of the average.
[C] $I_r = 2.83\ S_r$.
[D] $I_R = 2.83\ S_R$.

TABLE 4 Precision Data for Yield Elongation

Material	Thickness, mils	Average, %	$(S_r)^A$, %	$(S_R)^B$, %	$I(r)^C$, %	$I(R)^D$, %
PP	0.75	3.5	0.15	0.41	0.42	1.2
PET	2.5	5.2	0.26	0.92	0.74	2.6
PET	4.0	5.3	0.25	0.60	0.71	1.7
PET	7.0	5.4	0.14	1.05	0.40	3.0
CTA	5.3	5.4	0.19	0.99	0.54	2.8
PC	4.0	6.9	0.24	0.98	0.68	2.8
HDPE	1.0	8.8	0.32	1.82	0.91	5.2
LDPE	1.0	10.0	0.55	3.41	1.56	9.6

NOTE 1—See Table 3 for footnote explanation.

TABLE 5 Precision Data for Tensile Strength

Material	Thickness, mils	Average, 10^3 psi	$(S_r)^A$ 10^3 psi	$(S_R)^B$ 10^3 psi	$I(r)^C$ 10^3 psi	$I(R)^D$ 10^3 psi
LDPE	1.0	3.42	0.14	0.53	0.40	1.5
HDPE	1.0	6.87	0.27	0.81	0.76	2.3
PC	4.0	12.0	0.34	0.93	0.96	2.6
CTA	5.3	14.6	0.20	1.37	0.57	3.9
PP	0.75	28.4	1.57	4.56	4.4	12.9
PET	4.0	28.9	0.65	1.27	1.8	3.6
PET	7.0	30.3	0.83	1.32	2.3	3.7
PET	2.5	30.6	1.22	2.64	3.4	7.5

NOTE 1—See Table 3 for footnote explanation.

TABLE 6 Precision Data for Elongation at Break

Material	Thickness, mils	Average, %	$(S_r)^A$, %	$(S_R)^B$, %	$I(r)^C$, %	$I(R)^D$, %
CTA	5.3	26.4	1.0	4.3	3	12
PP	0.75	57.8	4.4	12.7	12	36
PET	2.5	120	8.0	14.6	23	41
PET	7.0	132	5.8	10.6	16	30
PET	4.0	134	4.4	12.2	12	35
PC	4.0	155	5.4	17.1	15	48
LDPE	1.0	205	24.4	73.3	69	210
HDPE	1.0	570	26.0	91.7	74	260

NOTE 1—See Table 3 for footnote explanation.

TABLE 7 Precision Data for Tensile Energy to Break

Material	Thickness, mils	Average, 10^3 $in.\cdot lb/in.^3$	$(S_r)^A$ 10^3 $in.\cdot lb/in.^3$	$(S_R)^B$ 10^3 $in.\cdot lb/in.^3$	$I(r)^C$ 10^3 $in.\cdot lb/in.^3$	$I(R)^D$ 10^3 $in.\cdot lb/in.^3$
CTA	5.0	3.14	0.14	0.70	0.4	2.0
LDPE	1.0	5.55	0.84	2.47	2.4	7.0
PP	0.75	11.3	1.19	3.11	3.4	8.8
PC	4.0	12.9	0.59	1.55	1.7	4.4
HDPE	1.0	26.0	1.87	5.02	5.3	14.2
PET	2.5	26.1	2.13	4.20	6.0	11.9
PET	4.0	27.1	1.42	2.75	4.0	7.8
PET	7.0	28.4	1.71	2.72	4.8	7.7

NOTE 1—See Table 3 for footnote explanation.

Lampiran 13 Surat Keterangan Penelitian

1. Surat Keterangan Penelitian di Laboratorium Pusat Penelitian Farmasi USU

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN,
RISET, DAN TEKNOLOGI

UNIVERSITAS SUMATERA UTARA
FAKULTAS FARMASI

Jalan Tri Dharma No.5, Pintu 4, Kampus USU Medan 20155
Telepon: (061) 8223558 Fax. (061) 8219775
Laman: farmasi@usu.ac.id

Nomor : 4405 /UN5.2.1.11/PSS/2021 22 Desember 2021
Perihal : Izin Pemakaian Fasilitas Laboratorium

Yth. Pimpinan Laboratorium Pusat Penelitian Farmasi
Fakultas Farmasi USU
Medan

Dengan hormat, sehubungan surat Wakil Dekan Bidang Akademik dan Kelembagaan Fakultas Sains dan Teknologi Universitas Islam Negeri Sumatera Utara Medan Nomor B.1123/ST.I/ST.V.2/TL.00/12/2021 tanggal 08 Desember 2021 tentang Izin Penelitian di Laboratorium bagi mahasiswa:

Nama	: Sri Ayu Lestari
NIM	: 0705173072
Instansi/Fakultas	: Fakultas Sains dan Teknologi Universitas Islam Negeri Sumatera Utara Medan
Judul Penelitian	: " Pengaruh Penambahan Selulosa Jerami Padi Pada Pembuatan Bioplastik Berbasis Pati Kulit Pisang Raja dengan Plasticizer Sorbitol".

Berkenaan dengan hal tersebut diatas, kami mohon kiranya Saudara dapat memberi izin pemakaian fasilitas di laboratorium yang Saudara pimpin kepada mahasiswa tersebut diatas untuk melakukan penelitian. Bersama ini kami beritahukan apabila terjadi kerusakan alat selama penelitian menjadi tanggung jawab peneliti.

Selanjutnya kami minta kepada Saudara agar mengirimkan kepada kami surat keterangan bebas biaya administrasi penelitian bagi mahasiswa tersebut yang telah selesai melaksanakan penelitian dengan mempergunakan fasilitas laboratorium yang Saudara pimpin.

Demikian kami sampaikan, atas perhatian dan bantuan Saudara diucapkan terima kasih.

a.n. Dekan,
Wakil Dekan I,

Hari Ronaldo Tanjung, S.Si., M.Sc., Apt.
NIP 197803142005011002

Tembusan:
1. Dekan Fakultas Farmasi USU;
2. Wakil Dekan Bidang Akademik dan Kelembagaan Fak. Sains & Teknologi UIN SU Medan;

2. Surat Keterangan Penelitian di Laboratorium Teknik Mesin USU

IMPACT AND FRACTURE RESEARCH CENTRE
UNIVERSITAS SUMATERA UTARA
FAKULTAS TEKNIK
PROGRAM STUDI DEPARTEMEN TEKNIK MESIN
Jalan Tri Dharma – Kampus USU Medan 20155

SURAT IZIN PENGGUNAAN LABORATORIUM

Kepala Assisten Impact Fracture and Research Center (IFRC) dengan ini memberikan izin menggunakan Laboratorium untuk melaksanakan penelitian ini:

Nama	: Sri Ayu Lestari
NPM	: 1705172072
Status Peneliti	: Mahasiswa UINSU Fisika
Tanggal Waktu Pemakaian	: 24 Desember 2021
Judul Penelitian	: Pengaruh penambahan selulosa jerami padi pada pembuatan bioplasti berbasis pati kulit pisang raja dengan *plasticizer sorbitol*

Medan, 24 Desember 2021

(Fakhrur Rozy)

3. Surat Keterangan Penelitian di Laboratorium Kimia Dasar LIDA USU

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET, DAN TEKNOLOGI
UNIVERSITAS SUMATERA UTARA
LABORATORIUM KIMIA DASAR
SEKRETARIAT: GEDUNG UPT. PUSAT PERKULIAHAN DAN LABORATORIUM ILMU DASAR & UMUM
JALAN TRIDARMA NO.7 LT. I KAMPUS USU MEDAN TELP.8218603 – 82142110 PES. 289
MEDAN – 20155

SURAT KETERANGAN
Nomor: 508/Sie.UPT.LKD/2022

Yang bertanda tangan di bawah ini menerangkan bahwa:

NAMA **: SRI AYU LESTARI**
NIM **: 0705173072**
PRODI **: S1 FISIKA UIN**

Adalah benar nama yang bersangkutan di atas telah melakukan penelitian mengenai **"Pengaruh Penambahan Selulosa Jerami Padi pada Pembuatan Bioplastik Berbasis PAti Kulit Pisang Raja dengan Plasticizer Sorbitol"** dan yang bersangkutan tidak memiliki hutang piutang di laboratorium Kimia Dasar LIDA USU.

Demikian surat keterangan ini diperbuat untuk dipergunakan seperlunya.

Medan, 30 Mei 2022
Kepala,

Sabarmin Perangin-angin, S.Si,M.Si
NIP. 196912131997022001

RIWAYAT HIDUP

Data Pribadi

Nama	: Sri Ayu Lestari
Tempat Lahir	: Bandar Tongah
Tanggal Lahir	: 18 November 1998
Jenis Kelamin	: Perempuan
Agama	: Islam
Alamat	: Desa Tuk Jimun, Kec. Kemuning, Kab. Indragiri Hilir, Prov. Riau

Latar Belakang Pendidikan

- 2004-2010 Sekolah Dasar (SD) Negeri 095254
- 2010-2013 Sekolah Menengah Pertama (SMP) Di Mts Al-Hidayah Laras
- 2013-2016 Sekolah Menengah Atas (SMA) Negeri 1 Dolok Batu Nanggar

Pengalaman Organisasi

- 2017 Himpunan Mahasiswa Islam (staff kaderisasi cabang SAINTEK)
- 2018-2019 Senat Mahasiswa Fakultas UINSU (anggota)
- 2019-2020 Himpunan Mahasiswa Jurusan Fisika UINSU (wakil sekretaris)
- 2019-2020 Asisten Laboratorium Elektronika Dasar

Pengalaman Kerja/Magang

- 2016-2017 Private Teacher
- 2020-2021 Magang di PT. Kreasibeton Nusapersada