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Effect of Packaging Materials and Moisture Level on Pearl Millet Stored Under Ambient Condition

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A B S T R A C T

Pearl millet is the most widely grown type of millet. Grains are a valuable source of numerous nutrients and minerals, and because they include phytochemicals, they support optimum health. One of the earliest groups of grains that humans have discovered is the group of small-seeded grasses known as millets, which are widely grown as cereal crops around the world. In the present study, the effects of packaging material and moisture level on pearl millet stored under ambient conditions were determined. Storage containers like polyethylene bags, metal containers, earthen pots, and gunny sacks were used for the comparison. The pearl millet was stored at various initial moisture content levels at 6%, 8%, and 12% using the above-mentioned storage containers. Seed moisture content, germination percentage, and germination index were all increased with an increase in the initial moisture content of pearl millet.

Keywords:Storage;Polyethylene Bags;Metal Containers;Earthen Pots;Gunny Sacks; Moisture Content.

1. Introduction

Millet (*Pennisetum glaucum* R. Br.) is a popular and wholesome grain in Asia's semi - arid regions and arid ecosystems. Pearl millet is a nutritive grain that is grown in semi-arid places across the world. Because it is largely milled at home without being discarded, and fats mostly in grain were absorbed while becoming rancid just several days as a result of oxidative rancidity. India remains the world's largest producer for pearl millet. In average, pearl millet kernels have more fat (7.0- 8.1%) than some other crops, as well as its dough has poor preserving qualities, particularly when exposed to surprisingly high oxygen levels and humidity[1,2]. This is due to lipoprotein degradation caused by lipolysis and carboxylic groups of de-esterified lipid. The fat breakdown in millet kernel is caused by the hydrolytic enzymes, which again is prevalent in the mesocarp, mesodermal shell, and seed, resulted a distinct smell in the grains and its by-products[3,4]. The degradation of oil intermediates can be controlled by thermally treating grain by dry or wet heating. Yadav et al. used high temperature pre-treatment of pearl millet grains to prolong the storage of pearl millet flour to 60 days at room temperature. The producers' struggle to get high-quality seed poses a significant barrier to the spread of grain agriculture. It was noted that millet grain has a limited shelf life and reduces health extremely quickly, even when stored in a suitable water repellent container.

While preserved in airtight containers, pearl millet can really be preserved longer over a year while retaining strong germination and vigour, according to author[5,6]. Among the most crucial elements affecting the durability of seedlings in preservation is the storage containers or packing materials. Grain seeds moisture content varied significantly in response to the storage jar used at various sampling dates (Rahman et al., 2010). When seeds are placed in humidity vessels, the air surrounding them has a relatively low humidity, which keeps the equilibrium moisture of the seeds minimal and prolongs their viable and potency author[7,8]. The suitability of the storage bin and the preliminary setting of seeds wetness were crucial attributes in the storage and life of such seedlings. Water activity and the temperature and humidity of the environment around the seeds had a major impact on the physical characteristics and storing capability of the crop. However, there are current reality that polyethylene sheets can serve as humidity enclosures. Compared to seedlings kept in vapour container, wheat seed housed in humidity packaging have a higher viability[9,10]. Relying on its starting state, seed worsened more slowly in impervious vessels than in permeability ones. To minimise seedling losses and maximise grain output, it is crucial to choose the right storage unit to retain the viability of grower seeds while it is in preservation. In light of the aforementioned circumstances, the current research was conducted to create secure storage methods to preserve the sustainability and vigour of cereal grains as intended.

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2. Materials and Methods

The experiment was conducted at Saveetha School of Engineering, SIMATS, Chennai during January to July 2022. Daily temperature (maximum, minimum and mean), total monthly rainfall and monthly relative humidity were collected from records of the Regional Meteorological Centre, Chennai. Mean total high and lowest temperatures, humidity levels, and total precipitation during the trial period. Highest and lowest temperatures have been recorded in April and May[11,12]. Monthly average relative humidity ranged from 75.21 to 86.23%.

Pearl millet, four storage container and four level of initial seed moisture content (6, 8, 10 and 12%) were used as treatment variables. The experiment was laid out in a Completely Randomized Design with three replications[13,14]. The crop was harvested at full maturity and after proper processing, cleaning and drying the seed was stored in polythene bags, metal containers, gunny sacks and earthen pots until used for experimentation. The seed was dried in the sun on the cemented floor to about 6% initial seed moisture content (SMC). Just before final storage the seed was re-hydrated at 70% relative humidity (RH) for required period of time to obtain targeted moisture contents were achieved. Every container has been totally filled using grain according to the trial specifications before becoming sealed. At 50, 100, 150, and 200 days following preservation, the grain was examined for several quality characteristics (DAS). The containers were kept in the laboratory under ambient room condition (25-32 C temperature and 78.64% relative humidity). The quality parameters tested were seed moisture content, germination percentage and vigour index.

Seed moisture content was measured using high constant temperature oven dry method following AOAC method (2003). About 5-8g of seeds were taken in the alluminium dish and dried in the oven at 130 oC for 2 hours (until constant weight reached). Germination test was done in sand culture method. Two third of a plastic dish (20 cm diameter and 15 cm deep) was filled with sterilized sand having 60% water holding capacity. Randomly collected 100 seeds from each container were placed into the sand for the germination test[15,16]. The germination dishes were placed in the germination cabinet and seedling evaluation was done at 8 days after placing the test. The number of normal seedlings per dish was regarded as the germination percentage. Germination index of seed was estimated from the seed set in the germination test by calculating the vigour index formula[17,18]. The seedling emerged each day having radical length of 2 cm or more was considered as germinated. At the end of the storage period, randomly selected 100 seeds from each seed lot in three replications were sown in the well-prepared field. The number of seedlings emerged each day were counted up to 15 days after sowing.

Data analysis was done following the analysis of variance (ANOVA) technique and mean differences were adjusted by DMRT at 5% level of significance with a computer package programme.

3. Results and Discussion

3.1. Seed moisture content (SMC)

The effect of storage container, initial seed moisture content and storage container on seed moisture content and germination performance was evaluated in terms of germination and germination index. The interaction effect of storage container and initial seed moisture content on millets was statistically significant at each of the observation dates during the storage period in 2022[19,20]. The moisture content of grains stored in metal jar with 6% initial MC were 6.90, 7.23 and 8.70%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those grains stored in polythene bag or metal container with 6% initial MC with, respectively (Table 1)[21,22]. The moisture content of grains stored in polythene bag at 12% initial MC were 12.40, 13.40 and 13.93%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of millets stored in metal container or polythene bag with 12% initial MC (Fig. 1)[23–25]. When seed could be packaged in moisture proof containers, the relative humidity of the air around the seed remains low, then the seed equilibrium moisture remains low[26,27]. Similar genetic variations in moisture content of millet seed have also been reported by author. These results are in good agreement with those reported author.

Table 1. Effect of initial moisture content and storage container on seed moisture content

Storage Container	Moisture Content Level 6%	Moisture Content Level 8%	Moisture Content Level 12%
Metal Container	6.90	7.23	8.70
Polyethylene bag	12.40	13.40	13.93
Earthen pot	12.70	14.53	14.70
Gunny sacks	12.99	15.64	16.89

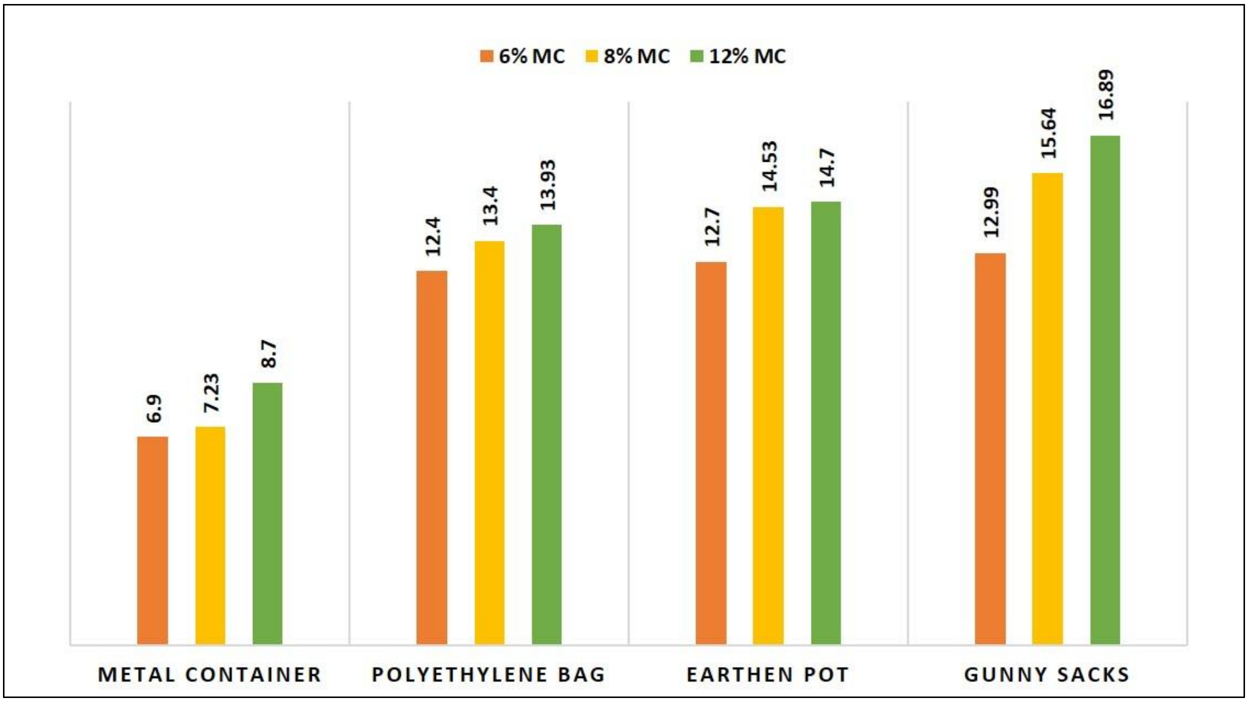

Fig. 1. Effect of initial moisture content and storage container on seed moisture content

3.2. Germination percentage

The interaction of effect of storage container, genotypes and initial seed moisture content on germination percentage was statistically significant at each of the observation dates during the storage period in 2022[25,28,29]. The germination percentage of grains stored in metal container with 6% MC were 96.66, 94.00, 93.33 and 92.00%, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of grains stored in gunny sacks or polythene bag with at 6% and 8% initial SMC is shown in the Fig. 2. Those values for pearl millet grains in polythene bag with 12% initial SMC were 76.00, 62.00, 24.00 and 6.33%, respectively (Table 2)[30,31]. These results are conformity of those reported by author[32,33]. Storage containers or packaging materials are considered as one of the most important factors influencing longevity of seeds in storage[34,35]. The containers had such a substantial influence on the moisture levels of agricultural crops at various storage measurement intervals.

Table 2. Effect of initial moisture content and storage container on germination percentage

Storage Container	Moisture Content Level 6%	Moisture Content Level 8%	Moisture Content Level 12%
Metal Container	98	91	87
Polyethylene bag	95	86	76
Earthen pot	88	78	68
Gunny sacks	78	65	59

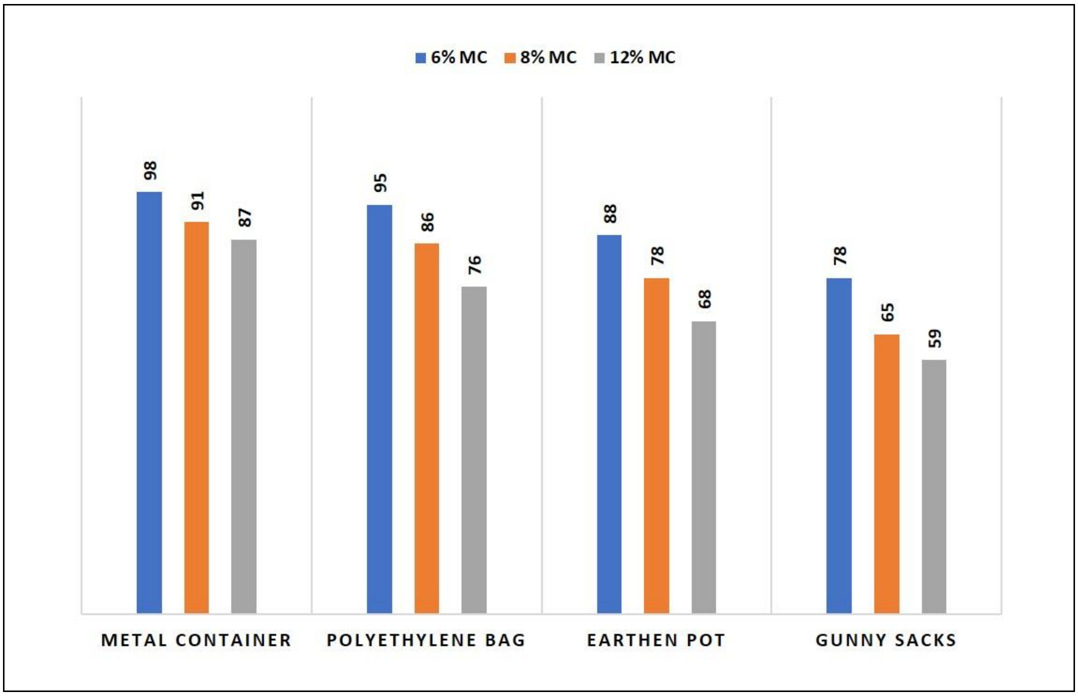

Fig. 2. Effect of initial moisture content and storage container on germination percentage

3.3. Germination index

The interaction of storage container and initial seed moisture content on germination index was statistically significant at each of the observation dates during the storage period in 2022[36,37]. The highest germination index for pearl millets stored in metal containers with 6% initial MC were 39.00, 35.00, and 26.33, respectively at 50, 100, 150 and 200 DAS and it was statistically at par to those of grains in gunny sacks with 8% initial MC, Pearl millets in polythene bag with at 6% and 8% SMC, grains in earthen pot with 6 or 8% initial MC (Table 3)[38–40]. Those values grains in polythene bag with 12% initial MC were 20.00, 12.00 and 5.00 and it was statistically identical to grains in metal container with 12% initial MC, respectively is shown in the Fig. 3. These results are conformity of those reported by the author[41–43]. The author reported that when seed could be packaged in moisture proof containers, the relative humidity of the air around the seed remains low, then the seed equilibrium moisture remains low and the seed maintains its viability and vigour for a longer time[44–46].

Table 3. Effect of initial moisture content and storage container on germination percentage

Storage Container	Moisture Content Level 6%	Moisture Content Level 8%	Moisture Content Level 12%
Metal Container	39	35	26.33
Polyethylene bag	38	33	27
Earthen pot	37	31	10
Gunny sacks	20	12	5

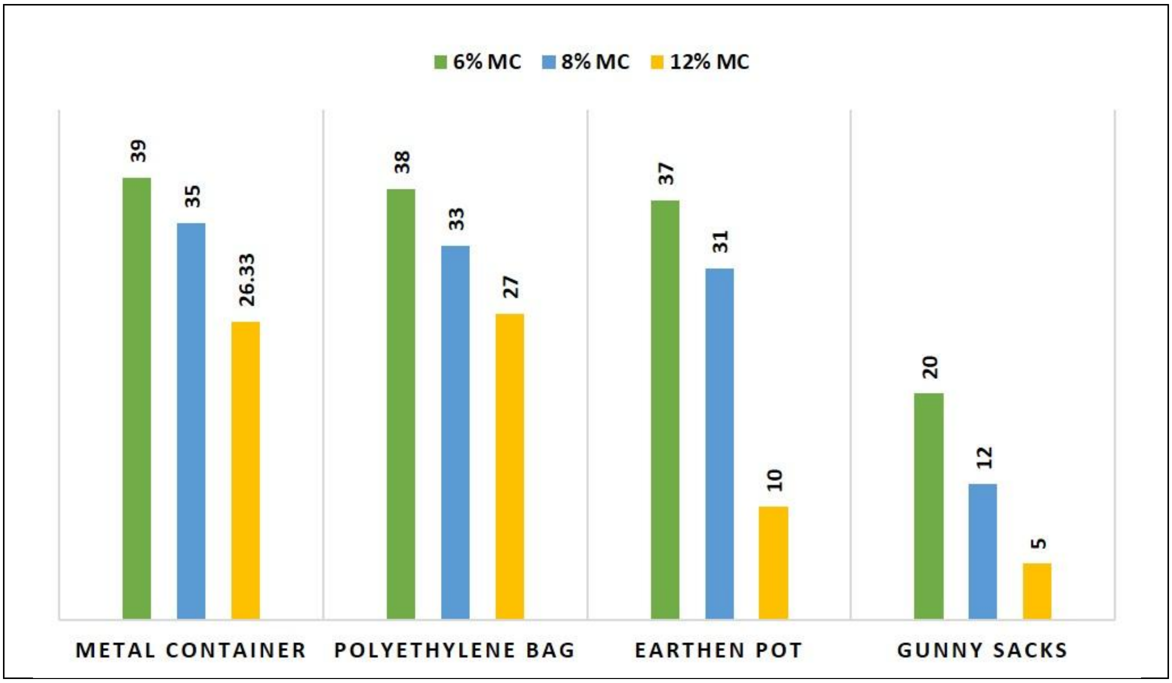

Fig.3. Effect of initial moisture content and storage container on germination percentage

4. Conclusion

The research revealed that pearl millet seeds may be securely kept in polyethylene bags or metal containers at 6 to 8% initial amount of moisture content while retaining good seed quality. Grain with a high level of moisture to the contrary side, should not be stored in an air-tight container.Such experiments might help researchers, milling, retailer vendor, and customer by allowing grain to be stored for a prolonged period without substantial effect in increasing value. It could also increase the use of millet grains, which are now under-utilized considering their various nutritional and medicinal advantages.

References

[1] G. Velmurugan, V.S. Shankar, M.K. Rahiman, R. Prathiba, L.R. Dhilipnithish, F.A. Khan, Effectiveness of silica addition on the mechanical properties of jute/polyester based natural composite, Mater Today Proc. (2022).

[2] V.S. Shankar, V. Thirupathi, A.P. Venugopal, Development of on farm ventilated storage system for Aggregatum onion, Int J CurrMicrobiolAppl Sci. 6 (2017) 1354–1361.

[3] G. Velmurugan, K. Babu, L.I. Flavia, C.S. Stephy, M. Hariharan, Utilization of grey Taguchi method to optimize the mechanical properties of hemp and coconut shell powder hybrid composites under liquid nitrogen conditions, in: IOP Conf Ser Mater Sci Eng, IOP Publishing, 2020: p. 012045.

[4] T. Sathish, G. Kaliyaperumal, G. Velmurugan, S.J. Arul, P. Nanthakumar, Investigation on augmentation of mechanical properties of AA6262 aluminium alloy composite with magnesium oxide and silicon carbide, Mater Today Proc. 46 (2021) 4322–4325.

[5] S. Sanjeevi, V. Shanmugam, S. Kumar, V. Ganesan, G. Sas, D.J. Johnson, M. Shanmugam, A. Ayyanar, K. Naresh, R.E. Neisiany, Effects of water absorption on the mechanical properties of hybrid natural fibre/phenol formaldehyde composites, Sci Rep. 11 (2021) 1–11.

[6] G. Velmurugan, T. Shaafi, M.S. Bhagavathi, Evaluate the tensile, flexural and impact strength of hemp and flax based hybrid composites under cryogenic environment, Mater Today Proc. 50 (2022) 1326–1332.

[7] G. Velmurugan, K. Babu, Statistical analysis of mechanical properties of wood dust filled Jute fiber based hybrid composites under cryogenic atmosphere using Grey-Taguchi method, Mater Res Express. 7 (2020) 065310.

[8] V. Ganesan, B. Kaliyamoorthy, Utilization of Taguchi technique to enhance the interlaminar shear strength of wood dust filled woven jute fiber reinforced polyester composites in cryogenic environment, Journal of Natural Fibers. 19 (2022) 1990–2001.

[9] T. Sathish, G. Kaliyaperumal, G. Velmurugan, S.J. Arul, P. Nanthakumar, Investigation on augmentation of mechanical properties of AA6262 aluminium alloy composite with magnesium oxide and silicon carbide, Mater Today Proc. 46 (2021) 4322–4325.

[10] V. Alagumalai, V. Shanmugam, N.K. Balasubramanian, Y. Krishnamoorthy, V. Ganesan, M. Försth, G. Sas, F. Berto, A. Chanda, O. Das, Impact response and damage tolerance of hybrid glass/Kevlar-fibre epoxy structural composites, Polymers (Basel). 13 (2021) 2591.

[11] V. Ganesan, V. Shanmugam, B. Kaliyamoorthy, S. Sanjeevi, S.K. Shanmugam, V. Alagumalai, Y. Krishnamoorthy, M. Försth, G. Sas, S.M. Javad Razavi, Optimisation of mechanical properties in saw-dust/woven-jute fibre/polyester structural composites under liquid nitrogen environment using response surface methodology, Polymers (Basel). 13 (2021) 2471.

[12] S. Sekar, S. Suresh Kumar, S. Vigneshwaran, G. Velmurugan, Evaluation of mechanical and water absorption behavior of natural fiber-reinforced hybrid biocomposites, Journal of Natural Fibers. 19 (2022) 1772–1782.

[13] G. Velmurugan, V. Siva Shankar, L. Natrayan, S. Sekar, P.P. Patil, M.S. Kumar, S. Thanappan, Multiresponse Optimization of Mechanical and Physical Adsorption Properties of Activated Natural Fibers Hybrid Composites, Adsorption Science & Technology. 2022 (2022).

[14] G. Velmurugan, T. Shaafi, M.S. Bhagavathi, Evaluate the tensile, flexural and impact strength of hemp and flax based hybrid composites under cryogenic environment, Mater Today Proc. 50 (2022) 1326–1332.

[15] V. Alagumalai, V. Shanmugam, N.K. Balasubramanian, Y. Krishnamoorthy, V. Ganesan, M. Försth, G. Sas, F. Berto, A. Chanda, O. Das, Impact response and damage tolerance of hybrid glass/Kevlar-fibre epoxy structural composites, Polymers (Basel). 13 (2021) 2591.

[16] L. Natrayan, P. v Kumar, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Velmurugan, S. Thanappan, Effect of nano TiO2 filler addition on mechanical properties of bamboo/polyester hybrid composites and parameters optimized using grey Taguchi method, Adsorption Science & Technology. 2022 (2022).

[17] T. Sathish, S.J. Arul, G. Kaliyaperumal, G. Velmurugan, P. Nanthakumar, Comparison of yield strength, ultimate tensile strength and shear strength on the annealed and heat-treated composites of stainless steel with fly ash and ZnO, Mater Today Proc. 46 (2021) 4305–4308.

[18] G. Velmurugan, A. Perumal, S. Sekar, M. Uthayakumar, Physical and mechanical properties of various metal matrix composites: A review, Mater Today Proc. (2021).

[19] M. Ponnusamy, L. Natrayan, S. Kaliappan, G. Velmurugan, S. Thanappan, Effectiveness of Nanosilica on Enhancing the Mechanical and Microstructure Properties of Kenaf/Carbon Fiber-Reinforced Epoxy-Based Nanocomposites, Adsorption Science & Technology. 2022 (2022).

[20] G. Velmurugan, V. Siva Shankar, L. Natrayan, S. Sekar, P.P. Patil, M.S. Kumar, S. Thanappan, Multiresponse Optimization of Mechanical and Physical Adsorption Properties of Activated Natural Fibers Hybrid Composites, Adsorption Science & Technology. 2022 (2022).

[21] P. Sabarinathan, V.E. Annamalai, R. Balakrishnan, A.C. Kuriakose, Process optimization for recovery of fiber backing from coated abrasive disks, Chem EngCommun. 208 (2021) 893–902.

[22] P. Sabarinathan, V.E. Annamalai, K. Rajkumar, K. Vishal, V. Dhinakaran, Synthesis and characterization of randomly oriented silane-grafted novel bio-cellulosic fish tail palm fiber–reinforced vinyl ester composite, Biomass Convers Biorefin. (2022) 1–18.

[23] L. Natrayan, S. Kaliappan, S. BaskaraSethupathy, S. Sekar, P.P. Patil, S. Raja, G. Velmurugan, D.B. Abdeta, Investigation on Interlaminar Shear Strength and Moisture Absorption Properties of Soybean Oil Reinforced with Aluminium Trihydrate-Filled Polyester-Based Nanocomposites, J Nanomater. 2022 (2022).

[24] G. Velmurugan, L. Natrayan, Y.S. Rao, P. Gaur, S. Sekar, R. Chebolu, P.P. Patil, P. Paramasivam, Influence of Epoxy/Nanosilica on Mechanical Performance of Hemp/Kevlar Fiber Reinforced Hybrid Composite with an Ultrasonic Frequency, Adsorption Science & Technology. 2022 (2022).

[25] G. Velmurugan, V. Siva Shankar, S. Kaliappan, S. Socrates, S. Sekar, P.P. Patil, S. Raja, L. Natrayan, K. Bobe, Effect of aluminium tetrahydrate nanofiller addition on the mechanical and thermal behaviour of luffa fibre-based polyester composites under cryogenic environment, J Nanomater. 2022 (2022).

[26] V. Siva Shankar, T. Pandiarajan, Engineering Properties of Black Gram Grain at Various Moisture Content, International Journal of Agriculture Sciences, ISSN. (2019) 975–3710.

[27] G. Velmurugan, V. Siva Shankar, S. Kaliappan, S. Socrates, S. Sekar, P.P. Patil, S. Raja, L. Natrayan, K. Bobe, Effect of aluminium tetrahydrate nanofiller addition on the mechanical and thermal behaviour of luffa fibre-based polyester composites under cryogenic environment, J Nanomater. 2022 (2022).

[28] T. Sathish, S.J. Arul, G. Kaliyaperumal, G. Velmurugan, P. Nanthakumar, Comparison of yield strength, ultimate tensile strength and shear strength on the annealed and heat-treated composites of stainless steel with fly ash and ZnO, Mater Today Proc. 46 (2021) 4305–4308.

[29] M. Ponnusamy, L. Natrayan, P.P. Patil, G. Velmurugan, Y.T. Keno, Statistical analysis on interlaminar shear strength of nanosilica addition with woven Dharbai/epoxy hybrid nanocomposites under cryogenic environment by Taguchi technique, Adsorption Science & Technology. 2022 (2022).

[30] V.S. Shankar, T. Pandiarajan, S. Ganapathy, Hermetic storage of black gram in metal bin and flexible storage bags, Indian Journal of Entomology. 81 (2019) 390–393.

[31] V.S. Shankar, G. Velmurugan, S. Kaliappan, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Anitha, G.G. Kailo, Optimization of CO2 Concentration on Mortality of Various Stages of Callosobruchus maculatus and Development of Controlled Atmosphere Storage Structure for Black Gram Grains, Adsorption Science & Technology. 2022 (2022).

[32] N. Maheswaran, M.H. Kumar, G. Velmurugan, K. Vijaybabu, S. Prabhu, E. Palaniswamy, Characterization of Natural Fiber Reinforced Polymer Composite, (2015).

[33] L. Natrayan, P. v Kumar, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Velmurugan, S. Thanappan, Water Retention Behaviour and Fracture Toughness of Coir/Pineapple Leaf Fibre with Addition of Al2O3 Hybrid Composites under Ambient Conditions, Adsorption Science & Technology. 2022 (2022).

[34] P. Rex, V. Ganesan, V. Sivashankar, S. Tajudeen, Prospective review for development of sustainable catalyst and absorbents from biomass and application on plastic waste pyrolysis, International Journal of Environmental Science and Technology. (2022) 1–16.

[35] D. Poornima, K. Hanumantharaju, V. Siva Shankar, K. Suresh Kumar, H. Ramya, Influence of moisture content and temperature on mechanical

extraction of oil from watermelon (Citrullus lanatus) seeds, Journal of Pharmacognos and Phytochemistry. 8 (2019) 275–279.

[36] G. Velmurugan, V.S. Shankar, M.K. Rahiman, R. Prathiba, L.R. Dhilipnithish, F.A. Khan, Effectiveness of silica addition on the mechanical properties of jute/polyester based natural composite, Mater Today Proc. (2022).

[37] S.U. Kumar, S. Sekar, S. Kumar, G. Velmurugan, Investigation of Tribological Characteristics of ZA 27 Alloy Under Various Lubrication Conditions, Wear IJLTEMAS0. 5 (2018) 800.

[38] V.S. Shankar, G. Velmurugan, S. Kaliappan, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Anitha, G.G. Kailo, Optimization of CO2 Concentration on Mortality of Various Stages of Callosobruchus maculatus and Development of Controlled Atmosphere Storage Structure for Black Gram Grains, Adsorption Science & Technology. 2022 (2022).

[39] P. Rex, V. Ganesan, V. Sivashankar, S. Tajudeen, Prospective review for development of sustainable catalyst and absorbents from biomass and application on plastic waste pyrolysis, International Journal of Environmental Science and Technology. (2022) 1–16.

[40] L. Natrayan, P. v Kumar, S. Kaliappan, S. Sekar, P.P. Patil, G. Velmurugan, M.D. Gurmesa, Optimisation of Graphene Nanofiller Addition on the Mechanical and Adsorption Properties of Woven Banana/Polyester Hybrid Nanocomposites by Grey-Taguchi Method, Adsorption Science & Technology. 2022 (2022).

[41] L. Natrayan, D. Veeman, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Velmurugan, H.F. Mekonnen, Influence of Nanosilica Particle Addition on Mechanical and Water Retention Properties of Natural Flax-and Sisal-Based Hybrid Nanocomposites under NaOH Conditions, Adsorption Science & Technology. 2022 (2022).

[42] L. Natrayan, T. Sathish, S. BaskaraSethupathy, S. Sekar, P.P. Patil, G. Velmurugan, H. Hailu, Interlaminar Shear, Bending, and Water Retention Behavior of Nano-SiO2 Filler-Incorporated Dharbai/Glass Fiber-Based Hybrid Composites under Cryogenic Environment, Adsorption Science & Technology. 2022 (2022).

[43] L. Natrayan, S. Kaliappan, B.S. Sethupathy, S. Sekar, P.P. Patil, G. Velmurugan, T. Tariku Olkeba, Effect of Mechanical Properties on Fibre Addition of Flax and Graphene-Based Bionanocomposites, International Journal of Chemical Engineering. 2022 (2022).

[44] M. Ponnusamy, L. Natrayan, P.P. Patil, G. Velmurugan, S. Thanappan, Multiresponse Optimization of Mechanical Behaviour of Calotropis gigantea/Nano-Silicon-Based Hybrid Nanocomposites under Cryogenic Environment, Adsorption Science & Technology. 2022 (2022).

[45] G. Velmurugan, K. Babu, L.I. Flavia, S.S. Kumar, M. Hariharan5e, Optimization on Mechanical Behavior of Hemp and Coconut shell powder Reinforced Epoxy Composites under Cryogenic Environment using Grey-Taguchi Method, (n.d.).

[46] G. Velmurugan, V. Siva Shankar, S. Kaliappan, S. Socrates, S. Sekar, P.P. Patil, S. Raja, L. Natrayan, K. Bobe, Effect of aluminium tetrahydrate nanofiller addition on the mechanical and thermal behaviour of luffa fibre-based polyester composites under cryogenic environment, J Nanomater. 2022 (2022).