A beneficial bio-waste with a zero-waste approach: peanut shell

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INTRODUCTION

The recycling of food and agricultural wastes, which are released as a result of domestic and agricultural uses, instead of throwing them into the garbage cycle and the environment, is of great importance both for the protection of the environment and the minimization of other environmental pollutants.

In recent years, human population growth, pandemic developments (COVID-19), climate change, and global warming have increased significantly. These increases endanger environmental health. Therefore, researchers are investigating different alternatives in terms of both human and environmental health.

This paper evaluates the possible use of the shell part of peanut, which is a food with high nutritional value.

ABOUT PEANUTS

Peanut (*Arachis hypogaea*) is a plant from the *Fabaceae* family. Peanut is one of the most important food products grown in countries with subtropical climates and is a valuable food used for health all over the world. Peanuts are edible, but their shells are discarded as waste. Their shells are an indispensable part of the garbage cycle.

Peanut is a valuable plant from the Fabaceae family, which contains 45-60% oil, % protein, 18% carbohydrates, vitamins and mineral substances in its seeds, especially in the oil industry and snack making, its stem and its shell are used in various ways. Although it is not known exactly when and how peanuts came to Turkey, Osmaniye province is the region with the highest peanut potential in the country.

PEANUTS PRODUCTION

According to the statistics of the Food and Agriculture Organization (FAO), peanut production is approximately 45 thousand tons and it was produced on 30 thousand hectares (FAO, 2018; Perea-Moreno et al. 2018). Peanut is grown mainly in Asia with a global production rate of 65.3%, followed by Africa with 26.2%, the Americas with 8.4% and Oceania with 0.1% (Figure 1).

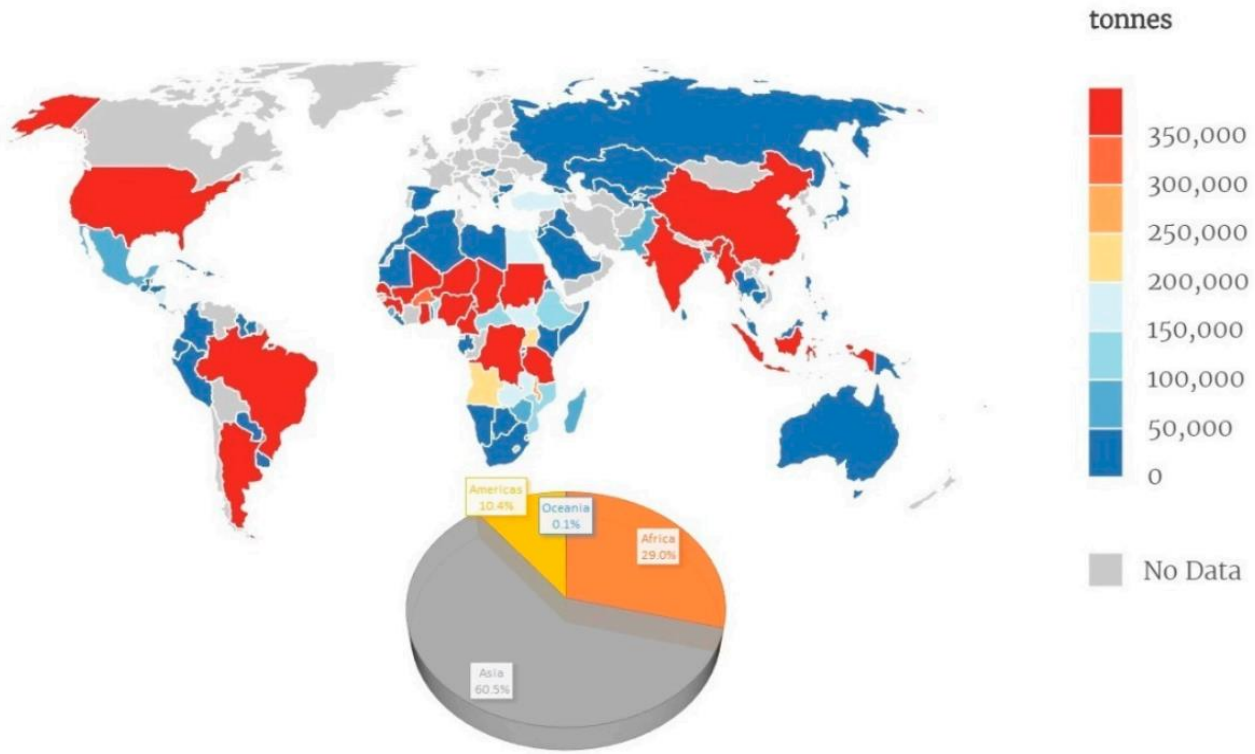


Figure 1. Worldwide peanut production **(Adapted from Perea-Moreno et al. 2018)**

PEANUTS COMPOUND

Peanuts are mostly consumed as snacks. For this purpose, peanut seeds are offered for consumption either without breaking the outer shell or after the shell is broken and the seeds are separated, by roasting them, removing the taste of raw peanuts and increasing their durability at the same time. The very high oil content in peanut seeds makes peanut an important place among many oil seeds in terms of vegetable oil production. Peanut oil is good in taste, clear in color, clear in appearance and highly resistant to high temperatures. It is especially preferred for foodstuffs that will be stored for a while after frying due to the antioxidant substances found naturally in it. Peanut oil is defined as the closest vegetable oil to olive oil among various vegetable oils in terms of both physical properties and nutritional value due to its high oleic acid content.

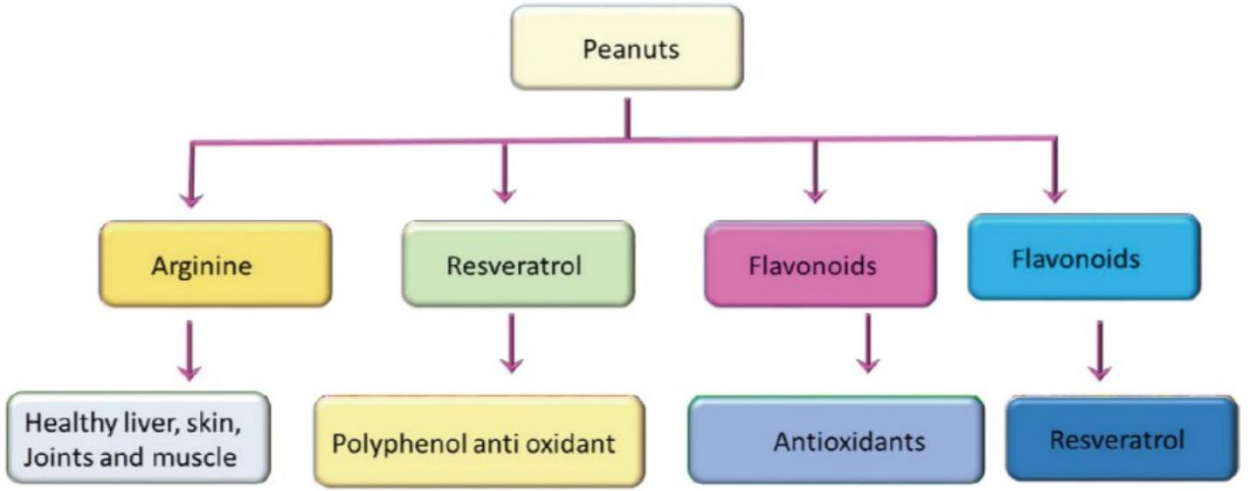
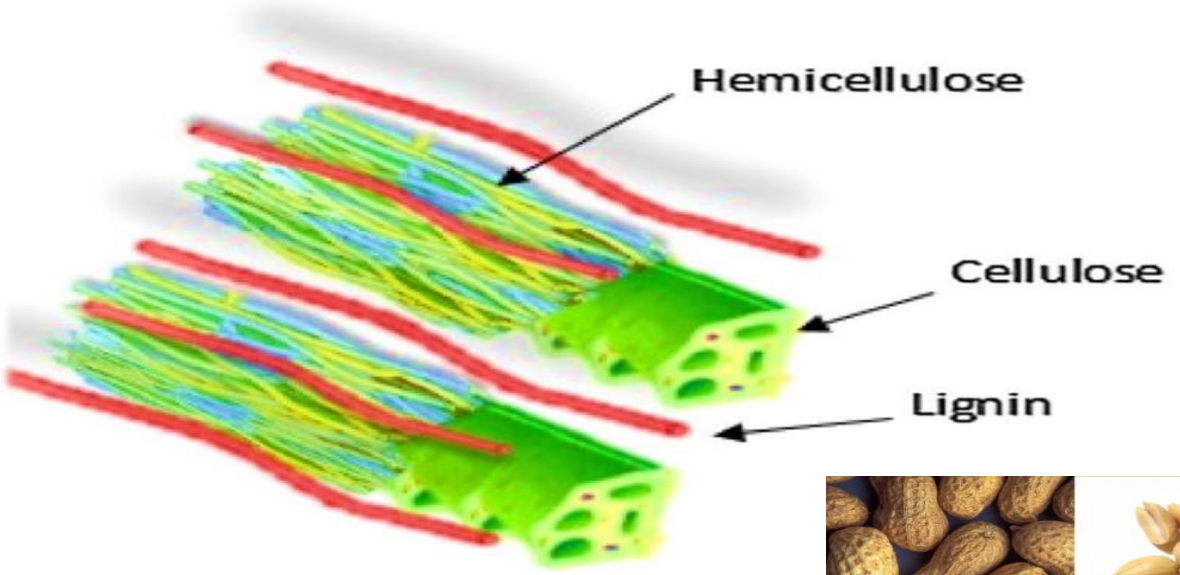
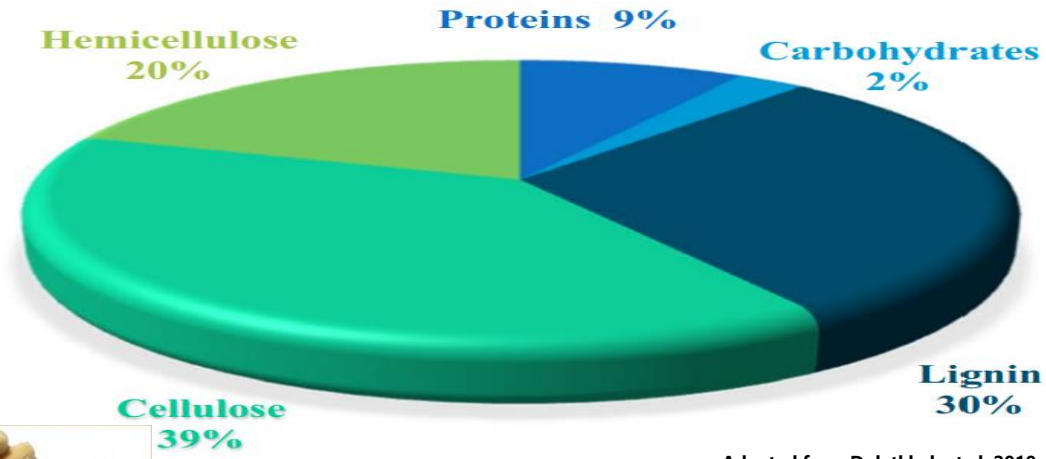


Figure 1. Peanut Compounds **(Adapted from Shahrajabian et al. 2021)**





Adapted from Dolatkhah et al. 2019

PEANUT SHELL

The peanut shell is a fibrous and lignocellulosic (cellulose content: 45%, hemicellulose content: 6%, lignin content: 36%) structure. In addition, it has a very slow degradation rate under natural conditions, which is a great advantage for other wastes (Paczkowski et al. 2021; Bobet et al. 2020).

DISPOSAL OF PEANUT SHELLS

Today, most the peanut shells are disposed of by incineration and burial, which causes environmental pollution. For this reason, this waste should be used in various sectors with a zero-waste approach.

Increasing environmental pollution all over the world day by day, unconscious energy consumption, and climate change have led countries to seek alternative solutions for environmental issues and to develop environmentally friendly-technological methods.

PEANUT SHELL
USAGE AREAS

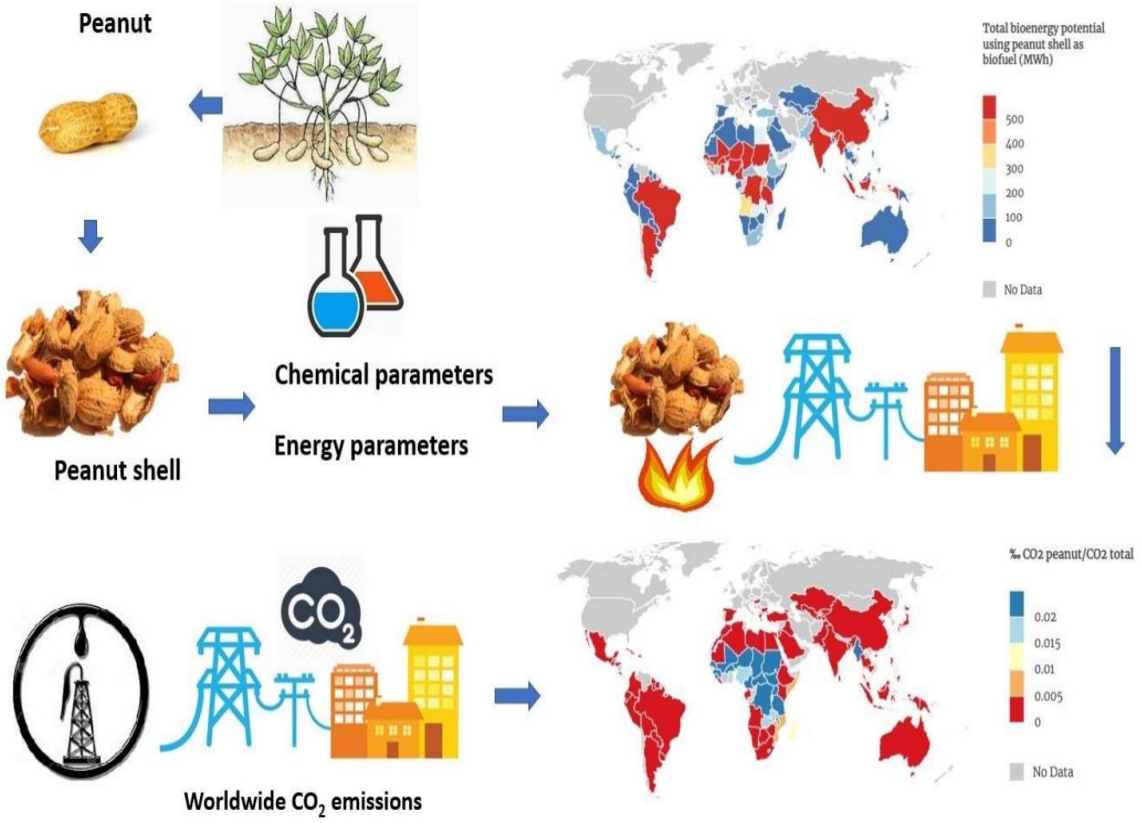
Peanut shell is used intensively in fields such as compost material, the energy sector (biofuel, biodiesel, CO2 emission reduction, etc.), cosmetics sector (nail polish, lipstick, etc.), food sector, soil improvement, drinking water and wastewater treatment (adsorbent, nano-material, filter etc.).

ENERGY SECTOR

Biodiesel, obtained from vegetable oil or animal fats, is an attractive substitute fuel source and is acquiring attention due to its non-polluted and eco-friendly nature.

Biofuel can be defined as the solid, liquid or gaseous fuel obtained from biomass. Bioethanol is a type of biofuel produced from various biomass

CO2 REDUCTION EMISSSION



Carbon dioxide emissions released into the atmosphere are an important environmental problem. An alternative to fossil fuels, which is accepted as one of the causes of climate change, is biomass. This section demonstrates the benefits of using peanut shells as a biofuel to reduce CO2 emissions.

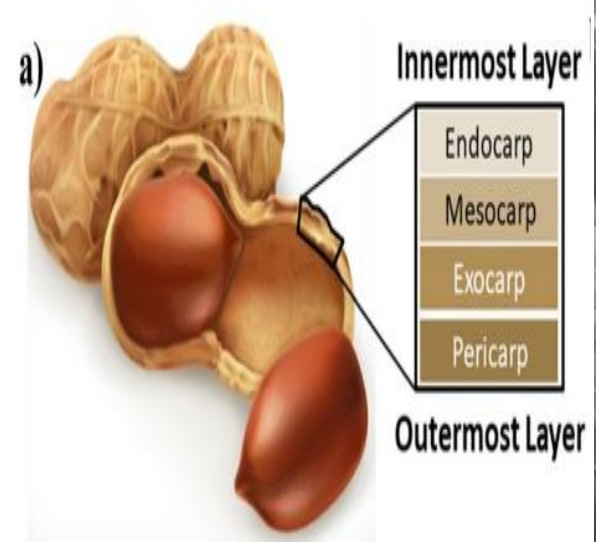
As seen in the figure, the peanut shells are converted with various parameters to reduce CO2 emissions. It also includes peanut shells for biofuel distribution and total CO2 reduction.

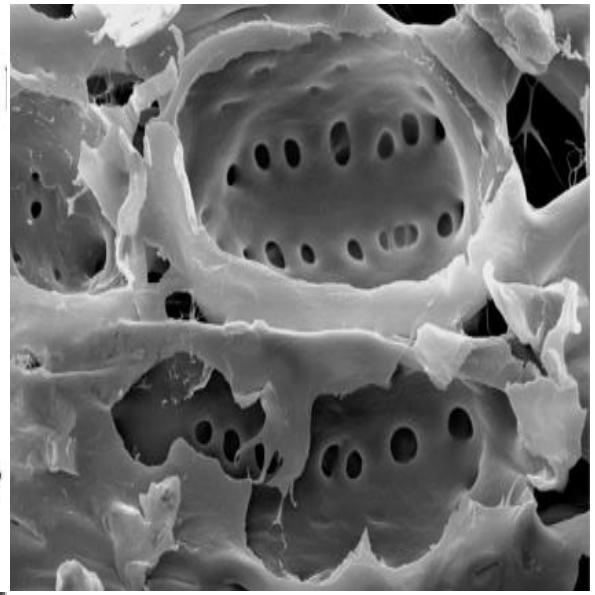
Global CO2 reduction will reach lower levels with the support of the energy produced by the peanut shell. Countries with high production of CO will rank high in the highest fuel emission savings, as they will be the largest energy producers with this biofuel. The top 10 countries are China, India), Nigeria, Myanmar, Argentina, Chad, Senegal, United Republic of Tanzania and the United States.

Figure 5. Methodology for reducing CO2 emissions by using peanut Shell **(Adapted from Perea-Moreno et al. 2018).**

COSMETIC&HEALTH SECTOR

On a global scale, food waste is used extensively in both health and cosmetics. In particular, the materials in the contents of wastes such as peanut shell are preferred in products such as nail polish and lipstick. Peanut and its products are very valuable in diet programs and sports nutrition in the health sector.





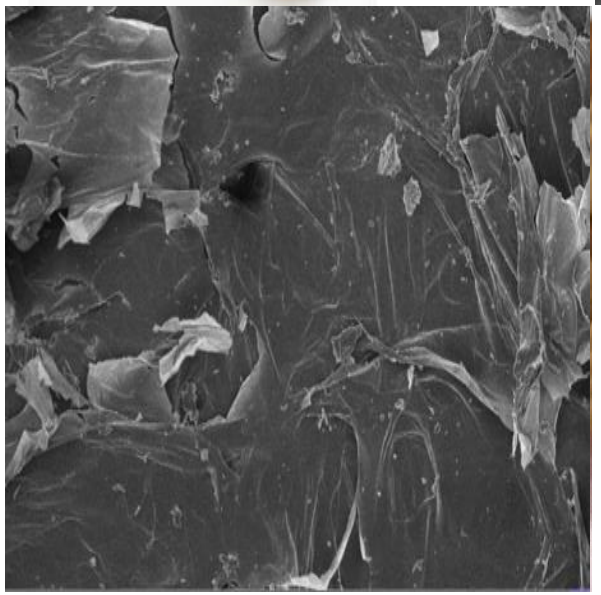


Table 1 Chemical compounds of adsorbents

	Adsorbent		
	Pistachio	Peanut	Almond
Chemical Characteristic	%Weigh	%Weigh	%Weigh
Organic matter	94	92	91
Ash content	4.0	3.8	3.4
Crude Protein	6.3	5.4	5.6
Crude fat	0.12	0.1	0.09
Lignin	16.33	36.1	27.54
Hemicellulose	25.30	5.6	18.82
Cellulose	43.08	44.8	38.47

DRINKING WATER WASTEWATER TREATMENT

Adsorption

Recycling of food wastes that are released as a result of domestic use instead of throwing them into the garbage cycle is of great importance both for the protection of the environment and the minimization of other environmental pollutants.

Various techniques are available for the removal of Pb^{+2} ions from environments such as water, air and soil. These can be listed as chemical treatment, coagulation/flocculation, membrane systems, electrochemical treatment, adsorption. Among these treatment methods, adsorption is considered as one of the good techniques used to remove heavy metal ions from different water environments due to its simple working principle (batch/semi-batch/continuous), high pollutant removal efficiency and low cost.

Peanut Shell as Adsorbent

In recent years, there are many scientific studies focusing on adsorbents of natural origin, which do not cause pollution as a result of their use. The use of waste material in pollutant removal and keeping this concept in the foreground is increasing day by day . Agricultural and industrial solid wastes, resins, activated carbon, chitosan, polymers, nanomaterials, zeolites, natural clays etc. is found. Peanut shell is also an easily accessible type of adsorbent in terms of both consumption and production. Chemical compounds of the adsorbent are given in Table 1.

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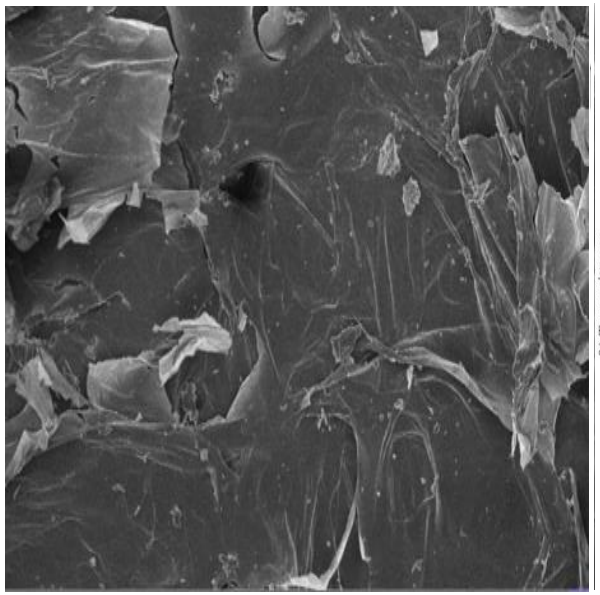

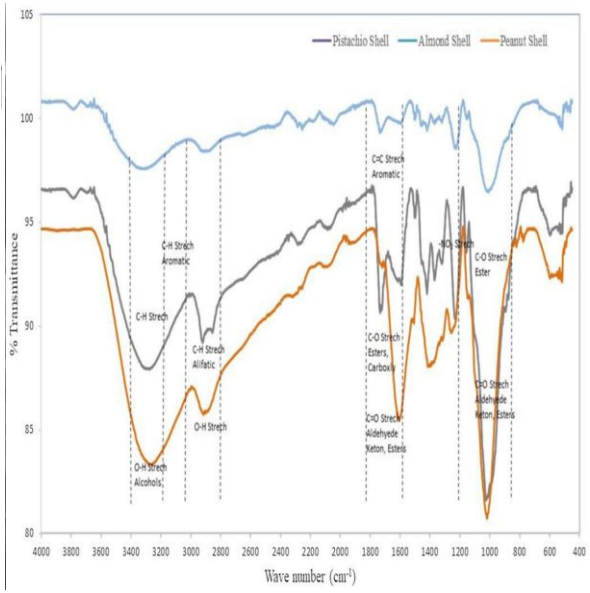

Wavenumber [cm^{-1}]	Band Assignment	Possible Compound
3340	OH stretching; alcohols, phenols, acids	cellulose, hemicellulose, lignin
2928, 2854	C-H stretching; methyl, methylene	cellulose, hemicellulose, lignin
1738	C=O stretching;	hemicellulose, lignin
1636	C=O stretching;	lignin
1609	aromatic skeletal, C=O stretching, absorbed OH	hemicellulose, lignin
1510	C=C-C aromatic ring stretching	lignin
1449	C-H deformation; methyl, methylene	lignin
1422	CH_2 bending, C=O stretching, CH deformation	cellulose, hemicellulose, lignin
1369	CH bending, CH stretching in CH_3	cellulose, hemicellulose, lignin
1318	CH_2 wagging, C-O stretching of substituted aromatic units	cellulose, hemicellulose, lignin
1261	syringal ring breathing, C-O stretching	lignin, xylan
1235	C-O stretching of guaiacyl unit	lignin
1150	C-O-C stretching	cellulose, hemicellulose
1100	aromatic C-H in plane deformation	lignin
1058	C-OH stretching, C-O deformation	cellulose, hemicellulose, lignin
1028	C-O stretching, aromatic C-H in plane deformation	cellulose, lignin
897	CH deformation of glucose ring	cellulose, hemicellulose
667	β-glycosidic ether ethyl linkage	cellulose, hemicellulose

PEANUT SHELL CHARACTERIZATION

The figure shows the FT-IR spectrum of the peanut shell. As expected, the spectrum of this lignocellulosic material is extremely complex. There are many functional groups such as cellulose, hemicellulose and lignin, and there are many functional groups such as carboxyl, carbonyl, hydroxyl and amino in chemical structures. The characteristic vibrational bands in the FT-IR analysis of the peanut shell are shown in the Table.

Morphological analysis of the peanut shell was performed using scanning electron microscopy and is shown in Fig. Simple pitted cell walls with caverns or pore structures were observed in the results of the SEM micrograph.

CONCLUSIONS

- Hydrogen production
- Bio-ethanol
- Biodiesel
- Building material
- Carbon nano-sheet
- Heavy metal adsorption
- Dye degradation
- SCP production

Adapted from Duc et al. 2019

Peanut shells are mostly considered agro-industrial waste and are released into the environment at levels of millions of tons each year. These shells, which are rich in lignocellulosic, degrade slowly in the natural environment. The use of valuable wastes in different areas in terms of sustainable economy and environment is of great importance today. However, peanut shell has a wide range of applications. This waste can be converted into a valuable bio-product to achieve zero waste generation. This study highlights the results of several scientific studies showing potential applications of peanut shells. With simple conversion processes, peanut shell can be converted into many bio-products with commercial applications such as biofuels, building materials, paper manufacturing, heavy metal adsorption, paint degradation.

OUR TEAMS

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Osmaniye Peanut Museum

Osmaniye Peanut Statue

T H A N K ' S