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A REVIEW

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Production of by-products from wastes of food processing industries

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● ABSTRACT ●

The specifically deals with the waste produce through industry used to the production of high value product likes pectin, phenolic compounds, compost, methane gas, growing media mixture, allelopathic compounds, dye compound (pigments), biomass production (fungus growth) as well as citrus pulp and apple pomace used to bioethanol production and by-products can result to exportable commodities, provide additional source of income to producers, generate employment and create investment opportunities for the country in future.

KEY WORDS : Food processing, By-product, Wastes

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India is the 2nd largest producer food in worlds. Total cultivated area of fruits and vegetables is around 12 M. hectare (*i.e.* 7% of total cultivation area). Main fruits produced in India are mango, banana, citrus, guava and apple; these account for almost 75 – 80% of total fruit production. The country produces around 140 M. tones of fruits and vegetables p.a. and accounts for about 10 % of the global production in fruits and about 13.7 % of global production in vegetables. India produces over 60 % of world's mangoes and 12 % of world's bananas. About 30-40% of fruits production go waste due to lack of proper processing and packaging. Only 2 - 3 % of the produce is processed in India as against Malaysia at - 83 %, Thailand - 72 % and Brazil - 70 %. Total number of fruits and vegetables processing units are 5200 found in India.

Sudhakar and Maini (2007) found that characterization of mango peel pectin. The peels are a rich source of pectin due to their high uronic acid, galactose, arabinose and rha mnose content. The majority of the pectin comes from cirtus peel and apple pomace. With a good recovery yield, a high average molar mass and intrinsic viscosity and a high degree of methylation, ammonium oxalate extracted mango pectin present good characteristics to be exploited industrially for their gelling properties.

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Pectin and polyphenol production from mango peel waste:

Sudhakar and Maini (2007) finding that the most potential extraction media was the ammonium oxalate for pectin production through mango peels. The ammonium oxalate extraction method produced the best results with higher yields, high molecular mass, and intrinsic viscosity.

HCl was found to partially degrade the pectin, while the water method produced poor yields. Despite these differences, the recovered pectin from all the methods were highly methylated, forming gels with large amounts of sugar (more than 55%) and acid.

An efficient method for manufacture of pectin from Totapuri mango peels was standardized by using 0.05N HCL that govern the recovery and quality of pectin. Among the different organic and inorganic acids, 0.05 N HCl was found to be the best for recovery of pectin from mango peels. Optimum yield of pectin was obtained by taking two extractions each for one-hour duration employing a peel: extractant ratio of 1:2 and by alcohol precipitation method.

Sirisakulwa *et al.*, (2010) reported that susceptibility of industrial mango peel waste to pectin degradation during storage at ambient conditions (25^{0}C, 63% relative humidity) for up to 5 h before by-product stabilization by drying. Depending on the interim storage period in the wet state, pectins were recovered from the dried peels by hot-acid extraction. Most important, pectin degradation during the temporary storage of the wet peels was insignificant, as revealed by yields, composition, average molecular properties, and techno-functional quality.

Muhlbauer and Carle (2005) reported that utilization of mango peels as a source of pectin and polyphenolics and byproducts of mango processing amount to 35–60% of the total fruit weight.

Eloisa and Hernandez (2009) studied that the waste products from mango processing industries to find profitable use.

Bioethanol production from apple pomace waste:-

Chatanta (2008) reported that bioethanol production from apple pomace left after Juice extraction. The production of ethanol from low cost lignocellulosic materials such as crop waste and horticulture waste has considerable promise as a future source of liquid transport fuel. Different microbial strains *viz., Saccharomyces cerevisiae* MTCC 173 (ethanol production), *Aspergillus foetidus* MTCC 151 (pectinase) and *Fusarium oxysporum* MTCC 1755 (cellulase) were used individually as well as in consortia for ethanol production from apple pomace in solid state fermentation (SSF) systems. With *S. cerevisiae* MTCC 173 (1% inoculum) 8.44% (v/w) ethanol was recovered after 72h of incubation at 30°C with Bucchi rotary vacuum evaporator and sugar concentration decreased to 0.25% and on the other hand, with co-cultures *i.e. S. cerevisiae* MTCC 173, *A. Foetidus* MTCC 151, *F. oxysporum* MTCC 1755 the ethanol increased to 16.09% (v/w) and sugar concentration further decreased to 0.15% after 72 h incubation at 30°C.

In general, food industry generates a large quantity of waste (*i.e.* peel, seed, pomace, rags, kernels, etc.) which is biodegradable in nature. Due to richness in carbohydrates, dietary fibres and minerals, such wastes have the potential to support the growth of microorganisms involved in the production of various products. Solid state fermentation of apple pomace by *Saccharomyces cerevisiae* and removal of ethanol followed by drying increase the nitrogen and fat content in the fermented and dried apple pomace for use as an animal feed. *S. cerevisiae,* in sequential interactive culture improves the soluble protein content of the fermented apple pomace. SSF of apple pomace using *Aspergillus niger* yield pectin esterase enzyme much more than submerged fermentation. Production of different biocolours by fermentation with *Chromobacter* sp., *Sarcina* sp., *Rhodotorula* sp. and *Micrococcus* sp. is possible along with citric acid production in SSF by *A. niger,* all having commercial value. Apple pomace utilization can become a model for the value addition of similar wastes and development of solid state fermented and downstream processing will go a long way in developing technology from laboratory to pilot scale [Publ. CSIR. (2006)].

Citrus fruit peels waste used to allopathic production:

Hisashi and Tanka (2004) reported that allelopathic potential of *Citrus junos* fruit waste from food processing industry. These results suggested that *C. junos* waste may possess allelopathic potential, and the waste may be potentially useful for weed management.

Aqueous methanol extracts of peel, inside and seeds separated from the fruit waste inhibited the growth of the roots and shoots of alfalfa (*Medicago sativa* L.), cress (*Lepidium sativum* L.), crabgrass (*Digitaria sanguinalis* L.), lettuce (*Lactuca sativa* L.), timothy (*Pheleum pratense* L.), and ryegrass (*Lolium multiflorum* Lam.). The concentrations of abscisic acid-â-D -glucopyranosyl ester (ABA-GE) in peel, inside and seeds separated from the *C. junos* fruit waste were determined, since ABA-GE was found to be one of the main growth inhibitors in *C. junos* fruit. ABA-GE may also be involved in the growth inhibitory effect of *C. junos* waste.

Single cell protein production from lemon pulp residue through fungi:

De Gregorio et al. (2001) studied SCP and crude pectinase production by slurry-state fermentation of lemon pulps. SCP and enzymes were produced by slurry-state flask cultivation of *Aspergillus niger* and *Trichoderma viride* on pulps from lemon juice clarification.

Biogas production from pineapple peel waste:

Ensilaging of pineapple peel resulted in the conversion of 55% carbohydrates into volatile fatty acids. The ensilage of pineapple processing wastes reduced the biological oxygen demand by 91%. Biogas digester fed with ensilaged pineapple peel resulted in the biogas yield of 0.67 m^3/kg volatile solids (VS) added with methane content of 65% whereas fresh and dried pineapple peels gave biogas yields of 0.55% and 0.41 m^3/kg VS added and methane content of 51% and 41%, respectively (Rani 2004).

Liquor production from citrus peel waste:

Lane (1983) compared anaerobic digestion of acidified citrus peel press liquors by completely mixed and up-flow anaerobic sludge blanket (UASB) processes.. Completely mixed digestion was overloaded at a hydraulic retention time of 10.7 day (organic load 7.41 g COD/1.d), whereas UASB digestion at retention time of 7 day (11.15 g COD/1.d) was stable and achieved 95% removal of COD.

Production of fatty acid and protein from banana peel waste:

Essien *et al.* (2005) reported that moulds grew comparatively well on banana peel substrates. In the production of valuable micro-fungal biomass which is rich source of protein and fatty acids.

Pectin extraction from orange peel waste:

Liu *et al.* (2006) reported that water-based extraction of pectin from flavedo and albedo of orange peels. The highest pectin and total nitrogen was produced by a sample to solvent ratio of 1:12.5. The amount of pectin extracted reduces as the pH increased, while the extractability of crude protein is not affected so significantly. Considerably more pectin was obtained by the Soxhlet method than by microwave extraction by a factor of two, with a longer extraction duration than the microwave extraction by a factor of 240, so microwave extraction showed a much higher extraction rate (per unit time) by a factor of 120. Pectin existed mainly in the albedo, but the flavedo still contained 27% of the amount of pectin in the total extract. The total pectin yield from the dried peel was 2.2%. The combination of hand-pressure and microwave on pectin yield from flavedo was 12% better than hand-pressure alone, which was also better than microwave extraction alone.

Ethanol production from pineapple cannery waste:

The continuous ethanol production from pineapple cannery waste by the respiration deficient strain *Saccharomyces cerevisiae* ATCC 24553 has been studied at 30°C and pH 4.5. Maximum ethanol yield (92.5% of the theoretical) was obtained at a dilution rate of 0.05 h^{-1}. The maximum values for volumetric ethanol and biomass productivities were 3.75 g_p l^{-1} h^{-1} and 0.63 g_x l^{-1} h^{-1}, respectively, at a dilution rate of 0.15 h^{-1}. The maintenance energy coefficient for *S. cerevisiae* ATCC 24553 was found to be 1.12 g_s g_x^{-1} h^{-1}. The maximum specific ethanol productivity and specific sugar uptake rate were found to be (0.98 g_p g_x^{-1} h^{-1}) and (2.54 g_s g_x^{-1} h^{-1}), respectively (Nigam, 1999).

Pellets production from apple juice waste:

Moosbrugger *et al.* (1993) studied grape wine distillery waste developed a pelletised sludge bed in a UASB system. Product formation along the line of flow in the pelletised bed was similar to that when treating a pure carbohydrate, apple juice waste. Pelletised sludge production was about 0.14 mgVSS/mgCOD removed (as against 0.42 mgVSS/mgCOD removed for apple juice waste), indicating a low influent COD carbohydrate fraction. The pellets were not as compact as with apple juice waste and were smaller (< 2 mm).

Composting as alternative method for waste management:

Schaub and Leonar (1996) reported that composting an alternative waste management option for food processing industries. In the food processing industries, up to 30% of incoming raw materials becomes waste rather than a value-added product. Dealing with this waste is an urgent matter for many of these industries as landfill sites close. In many cases, composting can provide a viable alternative method for managing organic wastes.

Processing food industry waste as a source of soluble sugars and fibre:

Susana (2008) reported that biological wastes contain several reusable substances of high value such as soluble sugars and fibre.

Olive mill waste mix as peat surrogate in substrate for soilless cultivation:

Roberto *et al.* (2010) reported that use of olive mill waste mix as peat surrogate in substrate for strawberry soilless cultivation. The use of OMWM showed high compatibility in soilless strawberry cultivation being an effective and cheap alternative to peat, therefore, a realistic cost reduction for growers was evident. The relatively high amount of nutrients found in the growth media at the end of strawberry cultivation meant that it can be recycled in agriculture as soil amendment

Conclusion:

The specifically deals with the waste produce through industry used to the production of high value product likes pectin, phenolic compounds, compost, methane gas, growing media mixture, allelopathic compounds, dye compound (pigments), biomass production (fungus growth) as well as citrus pulp and apple pomace used to bioethanol production and by-products can result to exportable commodities, provide additional source of income to producers, generate employment and create investment opportunities for the country in future.

● Literature Cited ●

Babel, S., Fukushi, K. and Sitanrassame, B. (2004). Effect of acid speciation on solid waste liquefaction in an anaerobic acid digester *Water Res.*, **38** (9) : 2417.

Chatanta, D. K. (2008). Bioethanol production from apple pomace left after juice extraction, *Internet. J. Microbiol.* ™ ISSN: 1937-8289

Couto, Susana Rodríguez, (2008). Exploitation of biological wastes for the production of value-added products under solid-state fermentation conditions, *Biotechnology J.*, **3** (7) : 859–870.

Eloisa, M. and Hernandez, E. (2009). Waste products from mango processing industries find profitable use, *Biotechnol. & Food Sci. Cluster, UPLB.,* **10** (3) : 110-113.

Essien, J.P. , Akpan, E.J. and Essien, E.P. (2005). Studies on mould growth and biomass production using waste banana peel, *Pharma Nutrition*, 2005.

Gregorio De, A. , Mandalari, G., Arena, N., Nucita, F., Tripodo, M.M. and Lo Curto, R.B. (2001). SCP and crude pectinase production by slurry-state fermentation of lemon pulps, Department of Organic and Biological Chemistry, University of Messina, Salita, Sperone 31, 98166 S. Agata, Messina, Italy.

Hisashi, K.N. and Tanaka, Y. (2004). Allelopathic potential of *Citrus junos* fruit waste from food processing industry, *Biochem. & Food Sci.,* Kagawa University, Miki, Kagawa 761-0795.

Lane, A.G. (1983) Anaerobic digestion of citrus peel press liquors, *Environ. Technol.*, **4** (8 & 9) : 349 – 352.

Liu, Y., Shi, J. and Langrish, T. A.G. (2006). Water-based extraction of pectin from flavedo and albedo of orange peels, *Chemical Engg. J.*, **120** (3) : 203-204.

Moosbrugger, R.E., Wentzel, M. C., Ekama, G. A. and Marais, G. V. R. (1993). Treatment of wine distillery waste in UASB systems. Feasibility, alkalinity requirements and pH control. *Waste Management Problems in* Agro-*Industries* **28** (2) : 45-54.

Muhlbauer and Carle (2005). Utilization of mango peels as a source of pectin and polyphenolics, *Internat. J. Food Sci. & Technol.*, **38** (2) : 1578–1579.

Nigam, J.N. (1999). Continuous ethanol production from pineapple cannery waste*, J. Biotechnol.,* **72** (3) : 197-202.

Pub. CSIR, NPR Vol. 5 (4) [2006]. ISSN: 0975-1092, pages-289-296.

Roberto, A. , Alessandro, E. and Gianluca, B. (2010). Use of olive mill waste mix as peat surrogate in substrate for strawberry soilless cultivation, *Internat. Biodeterioration & Biodegradation*, **64** (7) : 670-675.

Schaub, S.M. and Leonar, J. J. (1996), Composting: An alternative waste management option for food processing industries, *Trends Food Sci. & Technol.*, **7** (8) : 263-268.

Sirisakulwat, S., Sruamsiri, P., Carle, R. and Neidhart, S. (2010). Resistance of industrial mango peel waste to pectin degradation prior to by-product drying, *Internat. J. Food Sci. & Technol.*, **45** (8) : 1647–1658.

Sudhakar, D.V. and Maini, S.B. (2007). Isolation and characterization of mango peel pectins. *Food Sci. & Technol.*, **17** : 97-104.

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