GREEN RESOURCES FOR A MULTIFUNCTIONAL CHEMICAL: PALM FATTY HYDRAZIDE

TUAN NOOR MAZNEE, T I; WAN MD ZIN, W Y; YEONG, S K and HAZIMAH, A H

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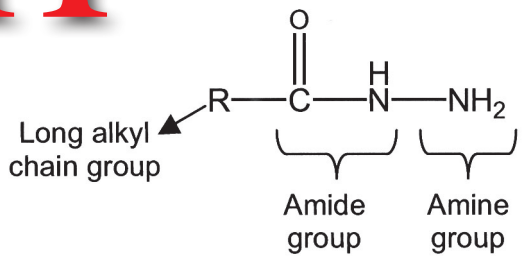
MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2011 MPOB TT No. 497

Hydrazides are useful compounds having a general formula of the following structure:



They make up a versatile class of nitrogen-substituted molecules with a high degree of chemical reactivity. They can be a precursor as well as an intermediate for many important organic molecules. Hydrazide of palm oil contains an amide, an amine group and a long-chain alkyl group, R. The importance of hydrazides is due to their chemical structure *i.e.* the presence of an amide group attached to a primary amine group. Many interesting and useful chemicals can be derived from this multifunctional structure.

A variety of methods have been developed to prepare hydrazides, depending on their application – whether for their biological function, organic synthesis and in the analytical fields. It is known that hydrazides can be prepared by numerous methods, *i.e.* through chemical synthesis which requires multiple steps, high temperature, high pressure and with associated by-products (Eissa, 2002; Perdicchia *et al.*, 2003; Emad *et al.*, 2008). Hydrazide can also be produced using green technology, which is based on the use of biocatalysts (Kobayashi *et al.*, 1999; Hacking *et al.*, 2000 and 2001; Mohamad *et al.*, 2008; Carpenter *et al.*, 2010).

Potential applications of hydrazides as surfactants of the non-ionic and anionic types have been studied by Amine *et al.*, (2004) and Eissa (2002), respectively. For the application of hydrazides as ligands, a lot of studies have been carried out on the formation of hydrazide-metal complexes in transition metal/organometallic chemistry of hydrazide ligand systems (Paul and Chadha, 1967; Malhotra *et al.*, 1992; Reddy and Katti, 1994; Perdicchia *et al.*, 2002; Mahalingam *et al.*, 2009).

A lot of attention has also been given to hydrazides for its important role in biological and therapeutic functions, such as having an anti-tuberculosis property in tuberculosis treatment (Bernstein *et al.*, 1951; Yale *et al.*, 1953; Manvar *et al.*, 2008), being an anticancer (Zimmer and Swamy, 1959; Mahalingam *et al.*, 2009), as well as radical-scavenging and antimicrobial agents (Malhotra *et al.*, 1992; Khan *et al.*, 2003; Kumar *et al.*, 2009; Liu *et al.*, 2009).

Application of hydrazides as corrosion inhibitors for mild steel, steel, aluminium, copper and zinc in an acidic aqueous environment has also been reported (Moussa *et al.*, 1976; Quraishi *et al.*, 2001; Ashry and Senoir, 2011). Other than that, hydrazide derivatives as chain extenders in a polyurethane dispersion system have been studied by Sukhorukova and co-workers (1984), Mohamed (1997) reported the application of aromatic hydrazides as stabilisers for rigid PVC against thermo-oxidative degradation.

Due to the multi-application potential of hydrazides and the limited availability of hydrazides produced directly from vegetable oils, MPOB took up the challenge of producing hydrazides directly from palm oil. The technology offered by MPOB is a simple and green process producing hydrazide directly from triacylglycerol of vegetable oils using an enzyme as a catalyst (*lipozyme RMIM* lipase). The enzyme used can be recycled. Mild reaction conditions are applied to produce this palm fatty hydrazide as opposed to the conventional method which involves high temperature, high pressure with unavoidable by-products. Using the enzymatic route, milder reaction conditions can

ISSN 1511-7871
9 771511 787001

Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia
P. O. Box 10620, 50720 Kuala Lumpur, Malaysia. Tel: 03-8769 4400 Fax: 03-8925 9446 Website: www.mpob.gov.my

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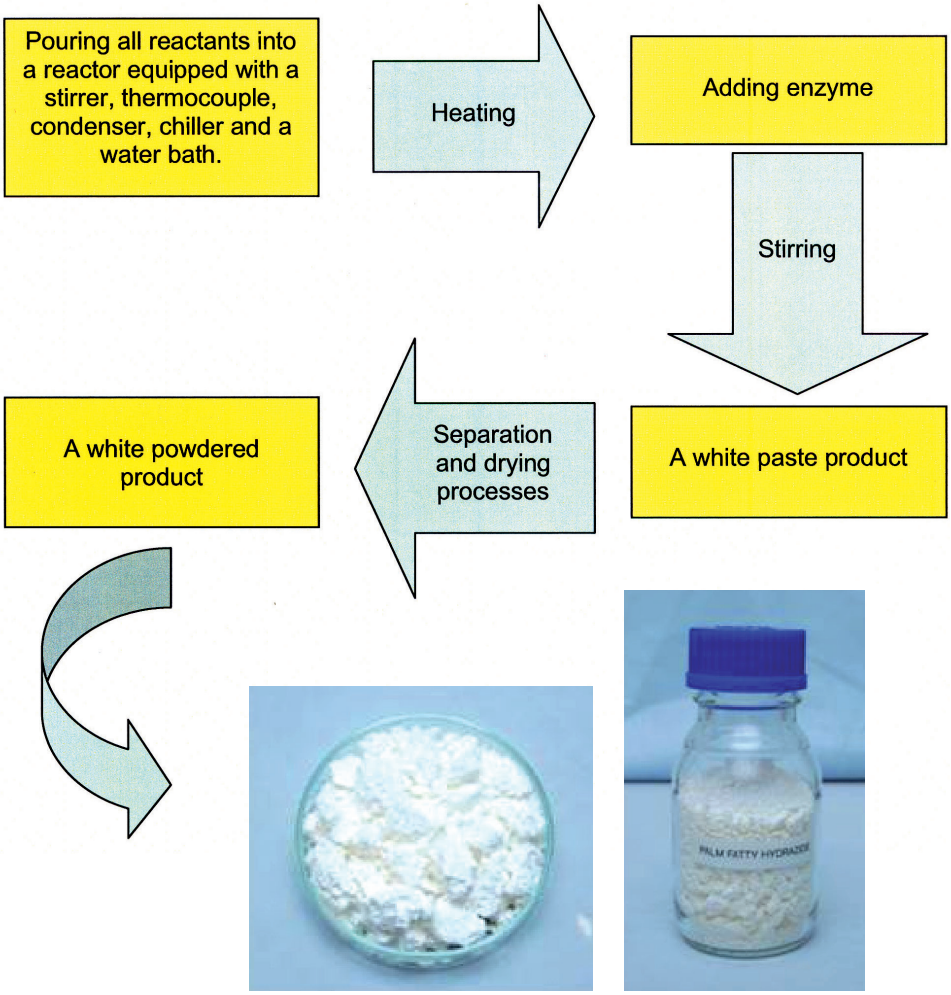
PRODUCTION OF PALM FATTY HYDRAZIDE



Palm fatty hydrazide.

be established with no formation of side products. The produced hydrazide can be used for further derivatisation into valuable compounds.

PROPERTIES OF PALM FATTY HYDRAZIDE

Item	Property
Nitrogen content (%)	9-10
Melting point (°C)	100-110
Purity (%)	>95
Solubility	Not soluble in water but soluble in ethanol, hexane, dichloromethane, dimethylformamide, chloroform and dimethylsulfoxide

POTENTIAL TAKERS

Potential takers of this unique intermediate product are the fine chemical industries that are involved in the production of pharmaceutical agents, agrochemical agents, anti-corrosion agents, chemicals for analytical fields, and surfactants.

BENEFITS

The product is potentially valuable as a starting material or an intermediate material, particularly for the production of fatty hydrazide derivatives, for example:

- surfactants – non-ionic and anionic;
- chelating agents or ligands;
- pharmaceutical agents – anti-cancer, anti-tumour, anti-tuberculosis and anti-microbial agents; and
- as chain extenders/thermo-oxidative stabilisers.

The product is produced using green technology from a renewable source; hence, it promotes an environmentally friendly process.

MARKET ANALYSIS

The price for commercially available hydrazide derivatives depends very much on the size of the packaging. Isonicotinic acid hydrazide used in the treatment of tuberculosis, for example, is sold at RM 47.25 for a 5-g packaging size, RM 129 for 100 g and RM 450 for 500 g. Another hydrazide derivative, maleic hydrazide, is an important herbicide used as a plant growth regulator as well as a weed-killer. The prices for 25 mg, 100 g and 500 g of maleic hydrazide are RM 39.00, RM 284.50 and RM 1125, respectively.

Palm fatty hydrazide, an intermediate for hydrazide derivatives, is produced at RM 2600.00 kg^{-1}. The cost of palm fatty hydrazide is calculated based on laboratory-scale production using the small packaging size of analytical grade chemicals. Therefore, it is anticipated that the cost for palm fatty hydrazide produced on a commercial scale will be very much lower than the price stated.

	Packaging size	Price (RM)
Isonicotinic acid hydrazide	5 g	47.25
	100 g	129.00
	500 g	450.00
Maleic hydrazide	25 mg	39.00
	100 g	284.50
	500 g	1125.00

CONCLUSION

Palm fatty hydrazide is a very good candidate for derivatisation of hydrazides into valuable compounds for a wide range of product applications, such as pharmaceutical agents, chelating agents, surfactants, corrosion inhibitors, thermo-oxidative stabilisers and agrochemicals. Furthermore, this palm fatty hydrazide is produced from 'green' resources and by a 'green' process.

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For more information, kindly contact:

Director-General
MPOB
P. O. Box 10620
50720 Kuala Lumpur, Malaysia.
Tel: 03-8769 4400
Fax: 03-8925 9446
www.mpob.gov.my