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Fruit juice boon for organic synthesis

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Abstract
Since past two decades, Green Chemistry or Sustainable Technology has demonstrated how fundamental scientific methodologies can protect environment and human health in an economically safer way. It focuses on the design manufacture and use of chemicals and processes that have no pollution potential or environmental risk, with high economical and technological feasibility. Lately, the role of naturally available fruit juice in organic synthesis has attracted the interest of chemists, particularly from the view of green chemistry. This review mainly summarizes the synthetic applications of fruit juice as a biocatalyst in different chemical transformations. This growing interest in fruit juice is mainly because of eco-friendly character, non-hazardous and cost effective. Fruit juice is now being routinely used in organic synthesis as homogeneous catalysts for various selective transformations of simple and complex molecules. The aim of present review paper is to summarize the utility of different fruit juices with emphasis on recent synthetic applications.

Keywords: Fruit juice, organic synthesis, biocatalyst, eco-friendly

Introduction
Green chemistry is a broad area of research developing from scientific discoveries about pollution remediation and it utilizes a set of principles that reduces or eliminates the use or generation of hazardous substance in all steps of particular synthesis or process. During the early 1990s the US Environmental Protection Agency (EPA) discovered the term Green chemistry to promote new chemical technologies that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and use of chemical products. The following 12 principles of Green Chemistry provide a way for chemists to important green chemistry:-

Prevention
It is better to prevent waste than to treat or clean up waste after it has been created.

Atom Economy
Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

Less hazardous chemical syntheses
Synthetic methods should be designed wherever practicable, to use and generate substance

Designing safer chemicals
Chemical products should be designed to achieve their desired function while minimizing their toxicity.

Safer solvents and auxiliaries
Unnecessary use of auxiliary substances (e.g. solvents, separating agents etc.) should be avoided wherever possible and made innocuous when used.

Design for energy efficiency
Energy requirement of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

Use of renewable feedstock's
Whenever technically and economically practicable, raw material or feedstock should be renewable rather than depleting it.

Reduced derivatives
Unnecessary derivatization (use of blocking groups, protection/deprotection, and temporary modifications of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

Catalysis
Catalytic reagents are superior to stoichiometric reagents.

Design for degradation
Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

Real time analysis for pollution prevention
Analytical methodologies need to be further developed to allow for real time, in process monitoring and control, prior to the formation of hazardous substances.

Inherently safer chemistry for accident prevention
Substances and the form of a substance used in a chemical process should be chosen so as to minimize the potential of chemical accidents, including releases, explosions, and fires.
In recent years, organic research is mainly focused on development of environmentally benign processes which involve the use of alternative reaction media to replace toxic and expensive catalyst or volatile and hazardous solvents like benzene, toluene and methanol commonly used in organic synthesis. Now a day's fruit juice used in organic synthesis as homogeneous catalysts for various selective transformations of simple and complex molecules.

Fruit juice of Lemon
The main ingredients of extract of citrus limonium species of lemon are moisture (85%), carbohydrates (11.2%), citric acid (5-7%), protein (1%), ascorbic acid or vitamin-C (0.5%), fat (0.9%), minerals (0.3%), fibres (1.6%) and some other organic acids (Deshmukh *et al.*, 2012). This juice is soluble in nature. Due to its acidic nature (ph=2-3), it works as acid catalyst in organic reactions. Lemon juice was reported to catalyze knoevenagel condensation reaction to synthesize arylidene malonitriles which shows antibacterial and antifungal activity (Bhuiyan *et al.*, 2012). The new approach for knoevenagel condensation by lemon juice is non polluting and does not employ any toxic material, so it is green method.

Fig 1: Lemon juice

Fruit juice of Tamarind
Tamarind fruit juice contain water (15-30%), protein (2.9%), fat (0.5-3%), total carbohydrate (56-82%), edible fiber (2.2-18.3%), ash (2.1-3.3%), calcium (86-190 mg), iron (1.3-10.9 mg), sodium (23-28 mg), potassium (62-570 mg). It also contains 41-58 % sugar of which 25-45 % is in form of non-reducing sugars and tartaric acid is (8-18 %) and ascorbic acid is (3-9 mg). An aqueous extract of tamarind fruit juice is acidic having ph 3 and acidity percentage is 50.3 %, that's why it will be worked as an acid catalyst in acid catalysed reactions (Siddig *et al*., 2006).

Fig 2: Tamarind juice

Fruit juice of Coconut juice
Cocos nucifera is a member of family Arecaceae (palm family). Coconut juice contain water 94.99 g), carbohydrates (3.71 g), protein (0.72 g or 1.2 %), fat (0.2 g), ascorbic acid or vitamin-C (12.4 mg or 3 %) as a soluble antioxidant. Coconut water is composed of many naturally occurring bioactive enzymes such as acid phosphatise, catalase, degydrogenase, diastase, peroxidise, RNA-polymerase etc. Coconut juice also an important class of biocatalyst in organic synthesis. The use of coconut juice as a biocatalyst for selective reduction of aromatic and aliphatic carbonyl compounds and dimerisation of aromatic nitro compound have been reported.

Fig 3: Coconut juice

Fruit juice of Watermelon

Fruit juices are naturally occurring used in organic synthesis. Now a day's fruit juice routinely is used in organic synthesis as homogeneous catalyst for various selective transformation of simple and complex molecule. These interesting properties of aqueous extract of fruit allow us to use watermelon juice as an environmentally benign catalyst for organic synthesis. Watermelon is one of the main vegetable crops grown and consumed all over the Mediterranean basin. China is the largest producer of watermelon with 68.9% of total production. Adrom *et al.* (2016) found the aqueous extract of watermelon is considered as an efficient, economical and environmentally friendly catalyst for the synthesis of 3,4,5-substituted furan-2 (5H)-ones. The high atom economy of reaction, short reaction time along with high purity mild reaction conditions and simple workup procedure make this procedure attractive.

Fig 4: Watermelon juice

Fruit juice of Barberry

Barberry have some important bioactive components in roots and/or fruits, such as calcium, sodium, sulphur, iron, zinc, vitamin C, Carbohydrates, organic acids and alkaloids e.g berberine and palmatine. Berberine, a yellow colour bitter substance belongs to large and diverse group of alkaloids called benzylisoquinolines. Hazeri *et al.* (2016) found that the aqueous extract of barberry is an efficient, economical, and environmentally benign catalyst for the synthesis of 3,4,5-substituted furan-2 (5H)- ones. The high yield of products, high atom economy, short reaction time, mild reaction conditions and simple workup procedure make this procedure attractive.

Fig 5: Barberry juice

Keora fruit juice

Keora (*Sonneratia apetala*) is one of tallest trees in Sundarfans mangrove forest. The species is distributed in India, Banladesh and Myanmar. This fruit contain some amount of potassium, iron, copper and due to presence of ascorbic acids, hexadecanoic acid, tetradecanoic acid, oleic acid, octadecanoic acid, fatty acid, its aqueous extract is acidic in nature, hence it could be work as acid catalyst for knoevenegel condensation. Keora fruit juice is edible, biodegradable, environmentally benign, non polluting, inexpensive, easy extraction procedure and safe so they posed no threat to environment.

Fig 6: Keora juice

***Acacia Concinna* pods**

Acacia concinna fruit is commonly known as Shikakai in Hindi is a member of Leguminosae sub family Mimosacaea. *Acacia concinna* is a medicinal plant grows in tropical rainforests of Sothern asia and its fruits are used for washing hair. The aqueous extract of these pods of fruits are acidic in nature due to presence of a acacia acid (trihydroxy monocarboxylic acid) with molecular formula $C_{36}H_{48}O_5$. Pods of Acacia concinna fruit extract as a catalyst could be viable, economic and eco-friendly catalyst and bye use of this catalyst reactions complete in short time with high purity and yields of products.

Fig 7: Acacia pods

Conclusion

This article focuses on the importance of fruit juice as a natural and biocatalyst in organic transformations. The fast growing intrest of fruit juice in organic synthesis is mainly due to their acidic properties, enzymatic activity, environmentally benign character, inexpensive and high commercial availability. This present article would serve the need of organic chemists in searching new applications of fruit juice for organic synthesis.

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