SHORT COMMUNICATION article

Effect of beverages on the disintegration time of drugs in the tablet dosage form

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Abstract: Disintegration is the most important step for drug bioavailability because after, the disintegration process, the ingredients of solid dosage forms dissolve and become bioavailable. Generally, the tablets and capsules should be taken with a glass of water otherwise the manufacturer gives instructions to use the proper beverage. Several drugs are taken with different forms of beverages to ensure easy swallowing of the tablet, masking the bad taste of the drug and overcoming the drug aftertaste, these beverages can influence the disintegration of the solid dosage form. The most common cold beverages consumed by the Libyan population are juice, milk, and Coca-Cola. These beverages are consumed without awareness of the possible effect of these beverages on drugs, especially over-the-counter drugs such as analgesic, antipyretic, and anti-inflammatory drugs that are taken without a prescription. This study aimed to evaluate the influence of three beverages, namely: orange juice, milk, and Coca-Cola on the disintegration time of four over-the-counter-drugs: Panadol, Congestal, Brufen, and Reality Extra using disintegration test of drugs in 0.1 N HCL and in hybrid medium prepared by combination of 150 ml 0.1 N HCL and 550 ml of beverage to simulate *in vivo* condition. The findings show that the orange juice significantly increases the disintegration time of all the investigated drugs. Coca-Cola significantly increases the disintegration time of Reality Extra, and slightly increases the disintegration time of Brufen, Congestal, and Panadol and the full-fat milk significantly increases the disintegration time of Reality Extra and Panadol while slightly increasing the disintegration time for Brufen and Congestal. It is concluded that commonly used beverages affect the disintegration time of the examined over-the-counter drugs. Patients should be advised to take these medications without beverages which may delay the disintegration and the onset of action of the drug.

Introduction

Oral solid dosage forms including tablets and capsules are widely used among patients because they have many advantages such as dose accuracy, ease of administration, portability, stability, and long shelf-life [1, 2]. The bioavailability of the drug depends on the ability of the oral solid dosage form to disintegrate quickly and completely in gastric media. The clinical performance of the solid dosage form is determined by the full disintegration of a tablet or capsule [3-5]. Disintegration is the method of breaking up a stable solid material while it is found in touch with a liquid medium that compromises the splitting of internal bonds of compact solid matter. Disintegration of the tablet is the interruption of inner bonds and eventual tablet breakdown into small fragments as a consequence of the penetration of an aqueous medium inside the tablets and this will

determine the drug availability from a tablet which depends on the ability of the tablet to be fully disintegrated in media [6]. The disintegration time is used to determine that the tablet will disintegrate during the specified time when it is installed in a medium under required test conditions [7, 8]. The disintegration test is a beneficial parameter for quality control of solid dosage forms and can be a critical test for drug release in highly soluble drugs [9, 10]. Disintegration is the most important step for drug bioavailability because after the disintegration process, the ingredients of solid dosage forms dissolve and become bioavailable [11]. Generally, the tablets and capsules should be taken with a glass of water otherwise the manufacturer gives instructions to use the proper beverage. In usual situations, the drugs are taken with different forms of beverages and the reasons behind that are to ensure easy swallowing of the tablet, mask the bad taste of the drug, and overcome the drug aftertaste, these beverages can influence the disintegration of solid dosage form [12]. The most common cold beverages consumed by the Libyan population are juice, milk, and Coca-Cola. These beverages are consumed on a large scale without awareness of the possible effect of these beverages on drugs especially over-the-counter (OTC) drugs like analgesic, antipyretic, and anti-inflammatory drugs [13]. This study aimed to evaluate the influence of three beverages, orange juice, milk, and Coca-Cola on the disintegration time of four OTC drugs: Panadol, Congestal, Brufen, and Reality Extra in Libyan patients.

Materials and methods

Drug products: Four OTC drug products available in the Libyan market in a tablet dosage form were selected for this study as described in **Table 1**.

Table 1: Description of the used drugs

Name of drug product	Production Company	Active ingredients	Use of medication	Batch number	Expiry date
Congestal	A	Paracetamol 650 mg Chlorpheniramine maleate 4.0 mg Pseudoephedrine HCL 60.0 mg	common cold and flu	230056	1/2026
Reality Extra	B	Paracetamol 325 mg Diclofenac sodium 50 mg Caffeine anhydrous 30 mg	fever and relief of headache, knee joint pain, muscle cramps, and dental pain	AT514	10/2025
Panadol	C	Paracetamol 500 mg	Analgesic for headache and fever	22J381	12/2026
Brufen	D	Ibuprofen 400 mg	Analgesic, antipyretic, & anti-inflammatory effect	24447/3J	6/2024

Study media: The disintegration was studied in 0.1 N HCL and three beverages were selected for the study which are orange juice (Judi), full-fat milk (Alnaseem), and Coca-Cola. Hybrid media were prepared for each one of the beverages, and a hybrid medium was prepared by a combination of 150 ml 0.1 N HCL and 550 ml of beverage.

Methods: Six tablets from each OTC pain medication were used in the test and each tablet was dropped into one basket tube of the USP/BP disintegration apparatus (ERWEKA), the basket rack was positioned in a vessel containing 700 ml of disintegration medium maintained at 37.0±2.0°C, so that the tablets remained below the surface of the liquid on their upward movement. 0.1 N HCL and three hybrid media were used as disintegration media, hybrid medium was prepared by a combination of 150 ml 0.1 N HCL and 550 ml of beverage to simulate *in vivo* conditions. Three beverages used in the test were orange juice, milk, and Coca-Cola. A motor-driven device was used to move the basket assembly containing the tablets up and down at a frequency of 30 strokes per minute, and the apparatus was operated for 30 minutes. The time at which the tablet was completely disintegrated and the fragments fell out of the stainless-steel mesh is recorded (disintegration time).

Statistical analysis: Differences between the mean groups were tested by Student *t*-test (paired two samples).

Results

All the OTC drugs used in this study were tested in 0.1 N HCL medium which is used as a control medium for the study, the average disintegration time for each drug product in 0.1 N HCL is described in **Table 2**. Both Reality Extra and Panadol showed 6.02 and 09.26 minutes, while Brufen and Congestal showed more than double of Reality Extra and Panadol (19.21 and 16.21 minutes, respectively).

Table 2: Disintegration time of drugs in 0.1 N HCL

Drug product	Disintegration time in minute
Brufen	19.21
Reality Extra	06.02
Congestal	16.21
Panadol	09.26

Effect of orange juice on the disintegration time: Orange Juice by manufactured Judi company was chosen for this study which is a well-known and common brand for juice in Libya. The disintegration test was performed in hybrid media which contains 150 ml 0.1 N HCL and 550 ml of orange juice to simulate the *in vivo* condition. The results are shown in **Figure 1** which explains a longer disintegration time compared to the control medium (0.1 N HCL) for the four tested drugs.
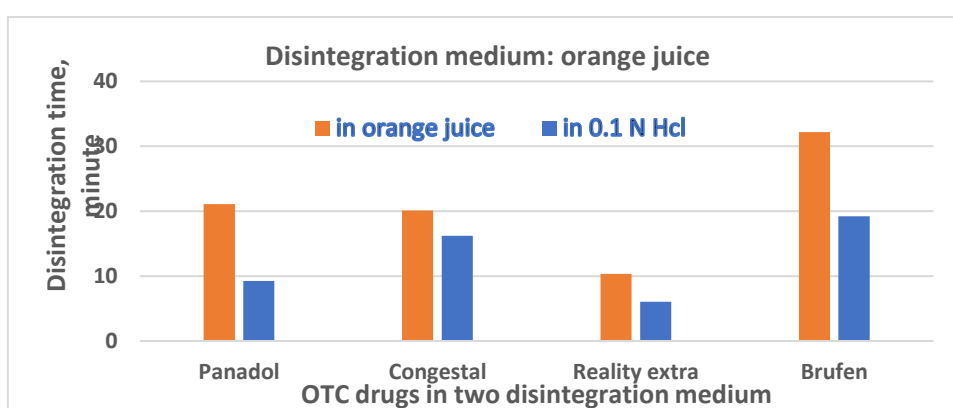

Figure 1: Effect of orange juice disintegration medium on the disintegration time of drugs

Effect of Coca-Cola on the disintegration time: Coco-Cola was selected because it is a well-known brand of soft drink that contains compressed carbon dioxide and it is a very common beverage after meals in the Libyan population. Disintegration test was performed in hybrid media which contains 150 ml 0.1 N HCL and 550 ml of Coca-Cola to simulate the *in vivo* condition. The delayed disintegration time compared to the control medium (0.1 N HCL) for the four tested drugs is shown in **Figure 2**.
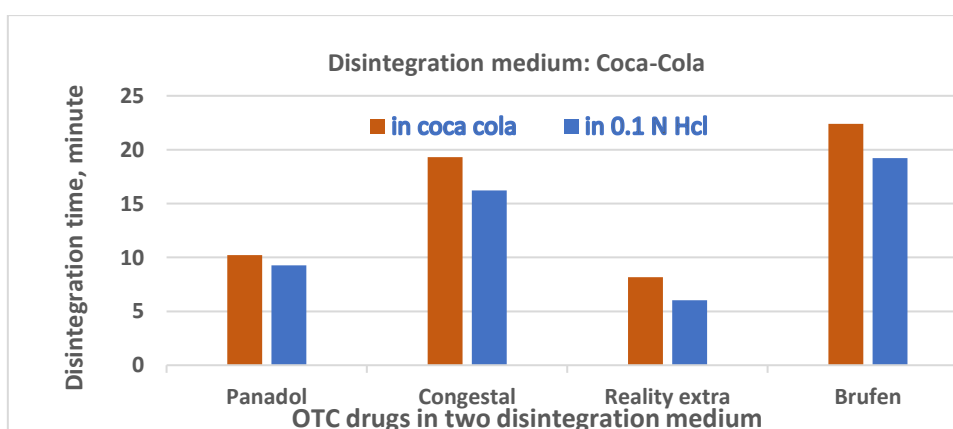

Figure 2: Effect of Coca-Cola disintegration medium on disintegration time of drugs

Effect of full-fat milk on the disintegration time: Alnaseem full-fat milk was used as a disintegration medium, it is a very common brand of milk and is used widely between populations. Disintegration test was performed in hybrid media which contains 150 ml 0.1 N HCL and 550 ml of the full-fat milk to simulate the *in vivo* condition. A comparison of disintegration time between milk and 0.1 N HCL is shown in **Figure 3**.
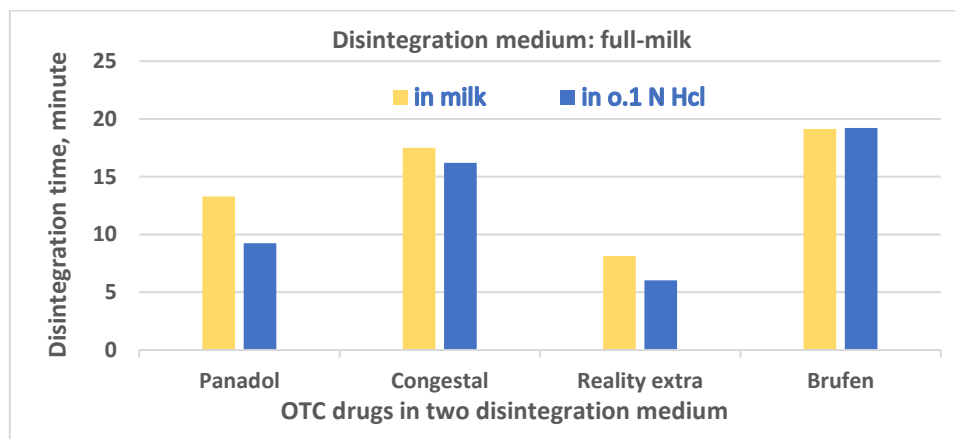

Figure 3: Effect of full fat-milk disintegration medium on disintegration time of drugs

Discussion

The Libyan population consumes OTC drugs on a large scale and leaflets of some OTC drugs do not provide any instructions about the type of liquid that is used with medication besides the patient's habits on how to take his medication. Some patients prefer sweet beverages like juices to mask the unpleasant taste of drugs and other patients to decrease the gastric irritation caused by drugs they prefer to take milk with medication [13]. It can be assumed that any beverage, including juices, milk, or Coca-Cola in case of after-meal medication can be administered with OTC drugs. This study was designed to test how the three beverages (orange juice, full-fat milk, and Coca-Cola) affect the disintegration time of the common OTC drugs (Panadol, Congestal, Brufen, and Reality Extra). Thus, the orange juice increases the disintegration time of the four investigated drugs by statistical analysis using a *t*-test (paired two samples for mean) of each drug result in orange juice and 0.1 N HCL I t was clear that orange juice highly significantly increases the disintegration time of reality extra ($p < 0.001$), Brufen ($p < 0.001$), Congestal ($p < 0.01$), and Panadol ($p < 0.001$) and were significant changes by $p < 0.05$. Similar to our findings, a study from Nigeria found that beverages including orange juice significantly delayed the disintegration time of paracetamol [12]. Another study found that orange juice delayed the disintegration time of hydrocodone bitartrate-acetaminophen tablets and ibuprofen tablets [14].

In this study, Coca-Cola increases the disintegration time of four drugs, and the statistical analysis revealed that each drug results in both Coca-Cola and 0.1N HCL, was observed that Coca-Cola significantly increases the disintegration time of Reality Extra ($p < 0.001$), and slightly increase the disintegration time of Brufen but not significant ($p = 0.207$), Congestal by $p < 0.05$, and Panadol by $p = 0.217$ (non-significant). The effect of Coca-Cola on the disintegration time was lower and less significant than the effect of orange juice. Another investigation compared the disintegration times of three drug products in water namely, Tramadol HCL, Ibuprofen, and the combination of hydrocodone bitartrate Acetaminophen with the disintegration in beverages including coca cola, this has a look at determined that coca cola extended the disintegration time of three medications [14].

This current study showed that full-fat milk delayed the disintegration time of Reality Extra, Congestal, and Panadol and did not affect the disintegration time of Brufen. The statistical analysis revealed that each drug

resulted in full-fat milk and 0.1 N HCL indicates that full-fat milk significantly increases the disintegration time of Reality Extra (p<0.01) and Panadol (p<0.001) while slightly increasing the disintegration time for Brufen (p=0.805) and Congestal (p=0.338). Published data for the impact of buttermilk and other drinks at the time of disintegration for three analgesics immediately release tablets, nimesulide, aceclofenac, and mefenamic acid, showed that disintegration times of three drugs were significantly delayed in buttermilk [15]. The mechanism of disintegration occurs by the entrance of liquid inside tablets followed by tablet swelling and its parting. Surface tension, the viscosity of the liquid, and contact angle affect the rate of liquid penetration inside the tablet and therefore the time for tablet disintegration [16]. For example, delayed disintegration time in milk being due to the penetration rate for milk is slow because of its low surface tension and high viscosity [17]. It is presumed that the rate of liquid penetration inside the tablets follows the order of beverage viscosity in such a way that low viscosity beverages such as 0.1 N HCL cause a faster disintegration and after those beverages with medium viscosity like Coca-Cola cause a moderate effect and finally high viscosity beverages as orange juice causing more delay in disintegration time [12].

Conclusion: This study was designed to test the effect of different beverages on the disintegration of drugs using hybrid media to simulate *in vivo* conditions, the results showed that orange juice significantly increases the disintegration time of Reality Extra, Brufen, Congestal, and Panadol. Coca-Cola significantly increases the disintegration time of Reality Extra, and slightly increases the disintegration time of the other three drugs. Full-fat milk substantially increases the disintegration time of Reality Extra and Panadol while slightly increasing the disintegration time of Brufen and Congestal. Overall, beverages that are commonly consumed by patients influence the disintegration time of examined OTC drug products and they are made to have a fast onset of action which means that any factor that affects drug disintegration may also affect the absorption and onset of action. Thus, the patient should advised to take these OTC medications without beverages that may delay their disintegration.

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