In vitro study of the effects of green, red, and black tea and coffee extracts on the mammalian intestinal smooth muscle motility(contractions & relaxations)

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Abstract:

Tea, is the most consumed drink in the world. Green tea, is a non-fermented tea and it contains more catechins than black tea. Red tea is gaining recognition for its free of caffeine, low tannin, and it contains the antispasmodic principle . On the other side, coffee, is a highly acidic drink and it contains the highest caffeine, but tea provides only 1/2 – 1/3 as much. In the present study we tried to investigate the effects of green, red, black tea and coffee extracts on the mammalian intestinal smooth muscle motility in an attempt to rationalize some of their medicinal uses.

Segments of jejunum was isolated from rabbits intestine and submerged in Tyroid's solution which has the same compositions of extra cellular fluid of the rabbit, they were exposed to different volumes and concentrations of green, red, black tea and coffee extracts and the response were recorded by a lever inject ink on a slowly moving drum. Green tea and red tea extracts induced a dose-dependent inhibitions of spontaneous activity of the jejunum, they induced a significant decrease in the amplitude of jejunal contractions and relaxations (motility), while the black tea extract does not show any noticeable effect on rhythmic spontaneous jejunal motility.

On the contrary, coffee extract , induced a significant increase in the amplitude of the spontaneous activity of the jejunum in a dose-dependent manor. This study provides a mechanistic basis for the medicinal uses of tea and coffee.

Keywords :- Tea, Coffee, Smooth muscle, Motility, jejunum.

Introduction:

Tea, is a product derived from leaf and bud of the plant *Camellia sinensis*, which is a member of the *theaceae family* [1]. It is one of the most widely consumed beverage in the world today, and its medicinal properties have been widely explored[2]. There are two main kinds of tea which are non herbal and herbal tea[3]. Non herbal teas can be further divided into three basic types: black, green and oolong tea[4].

The polyphenols found in tea are more commonly known as *flavonoids* or *catechins* [5]. Black and green teas both contain similar amount of flavonoids [6]. The four main catechins in the green tea are: Epigallocatechins-3-gallate (EGCg), epigallocatechin(EGC), epicatechin-3-gallate(ECG) and epicatechin(EC) [7]. Green tea also contains: Gallic acid and other phenolic acids such as chlorogenic acids, caffeic acid and flavonols such as kaempferol, myricetin and quercetin[8]. In black tea the polymerized catechins are theaflavins and thearubigins predominate[9]. Tea, whether cold or hot contains the same polyphenols [10], also it contains the similar caffeine, which is an alkaloid compound and is one of many alkaloids, including Theophylline and theobromine that occur naturally and in varying amount in tea leaves and coffee[11]. These compounds act as stimulant to the cardiac muscle, respiratory system, and the central nervous system[12]. They also act as a smooth muscle relaxant, diuretics and vasodilator[13]. Rooibos tea, which means red bush tea (also known as *aspalathus linearis*) is a leguminous shrub with needle- like leaves[14]. Its beverage with a characteristic sweet flavor, is rich in

volatile compounds, minerals, ascorbic acid and it is caffeine free[15].

Other than tea, coffee is a highly acidic drink, and it's second only to petroleum as the world most widely traded[16]. It belongs to the plants of the *family rubiacee.* On average, coffee contains more caffeine, but tea provides only 1/2 to 1/3 as much[17]. The chlorogenic acids in coffee modulate glucose uptake and gastrointestinal hormones[18].

Aim of the study:

The present study was conducted to investigate the effects of green, red, and black teas and coffee extracts on the mammalian intestinal smooth muscle motility (contractions&relaxations), in an attempt to rationalize some of their medicinal uses.

Materials and Methods:

1: Preparations of plant materials:

Tea and coffee, were purchased from the markets in Basrah as dried leaves. 250mg of each green, red, and black tea and coffee, were dissolved in 100ml of hot distilled water for 15min with shaking. The obtained extract was filtered to obtain a concentration of 2.5mg/ml, and stored at $3C^{o}$ until the experiments.

2: Animals:

Animals (rabbits) were brought from the markets. A total of fifteen male rabbits, weighing (1000-1500 gm), aged (18-24months) were used in this experiments. Animals are housed in 3 groups of (5 animals in each group) under a standard control (free access to food and water).

3:Apparatus and procedure:

Research tissue bath (Harvard) was used, it contains central vessel of 100ml size, enclosed within a water jacket which is kept at $37C^{o}$ by adjustable electric heater. The central vessel is filled with Tyroid's solution. A hollow glass tube end with a hook that can be lowered to the central vessel. The animals were scarified and the small intestine removed gently and cut off into pieces of about 3cm long and threaded by needle through all the coats near one end from the inside to the outside.
The movements of the piece were recorded by ink writing lever on a slowly revolving drum. After that 1ml of green tea extract was added to the central vessel, the effect of green tea extract on intestinal contraction and relaxation was recorded by the lever on the drum. Then the central vessel was washed and the piece was removed to start with a new one, and Tyroid's solution was added with a new extract (black, green, red tea and coffee) in (1ml) and (2ml) respectively, then each result was recorded on the drum to compared with control results(contraction and relaxation of mammalian intestinal muscles)[19].

Table (1) the effect of water extract of (green, red, black tea and coffee) on contraction and relaxation of mammalian intestinal muscle.

Substance	Volume	Amplitude of contraction and relaxation (mm)
D.W.	1mL	10 ±1.83
	2mL	10 ±1.83
Green tea	1mL(2.5mg/mL)	8 ±1.97
	2mL (5mg/mL)	4* ± 0.77
Red tea	1mL(2.5mg/mL)	7±1.43
	2mL(5mg/mL)	3* ± 0.65
Black tea	1mL(2.5mg/mL)	10±1.83
	2mL(5mg/mL)	10±1.83
Coffee	1mL(2.5mg/mL)	12±1.49
	2mL(5mg/mL)	16** ±1.21

* significant decrease ($p< 0.01$) in (RLSD)

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Data Analysis:- data were expressed as mean ± S.D, differences between control and tests groups were analyzed using SPSS 9 version, significant effect considered when the p value <0.01.

Results and Discussion :

The segments of the jejunum that submerged in Tyroid's solution which has the same compositions of extra cellular fluid of the rabbit, showed a spontaneous, rhythmic contraction-relaxation movements of the jejunal smooth muscle after the administration of 1ml and 2ml of distilled water and it represents the control amplitude record. Green tea and red tea extracts induced a dose-dependent inhibitions of the spontaneous rhythmic activity of the jejunum, moreover, they induced a significant *decrease* ($P<0.01$) in the amplitude of jejunal contractions and relaxations, while the black tea extract does not show any noticeable effect on the spontaneous jejunal activity. On the contrary, coffee extract induced a significant *increase* in the amplitude of jejunal spontaneous rhythmic activity ($P<0.01$) in a dose-dependent manor. The green and red tea extracts show an antispasmodic properties. They significantly decrease the jejunum motility ($P<0.01$) in a dose-dependent manner, that is reversely correlated to their volumes and concentrations. These findings were supported by the results from previous studies, suggested that epigallocatechins-3-gallate (EGCg) that is presented in human diet and originates mainly from tea leaves, induced a dose-dependent inhibition of spontaneous activity in the jejunum[20]. Also(EGCg) induced a decrease in the amplitude and frequency of jejunal contraction, moreover, the rythmicity of spontaneous activity was altered in the presence of (EGCg), so it inhibits the motility of jejunum by direct action on smooth muscle cells where a guanylate-cyclase-dependent mechanism may be partly involved [6]. Although green tea has not been officially recognized as a medicinal agent, but it is known to be effective against diarrhea due to the presence of *tannin*, which decreases intestinal activity and exerts an anti-diarrhoeal effect [21]. Regarding Rooibos tea extract which has been widely used for abdominal spasm and diarrhea[22], it possesses a combination of dominant K(ATP) channel activation and weak Ca^{++} channels antagonist mechanisms and hence justifies its use in hyperactive gastrointestinal disorders[23]. The effect of black tea extract on gastrointestinal system has been studied and it yields a conflicting results. Some studies indicated that the extract of black tea significantly accelerated the gastrointestinal transit in mice [24]. These finding suggest a cholinergic involvement and a partial role of prostaglandin and nitric oxide, also, the role of black tea polyphenols (thearubigins) fraction in the mechanism of action of black tea extract on jejunum motility[25], while other studies, demonstrated that the black tea extract having an anti diarrhoeal activity, thus indicating a role of opioid system in the anti-diarrheal activity of the extract [26]. In the present study we donot find any noticeable effect of black tea extract on jejunal motility. while, coffee, revealed a significant increase ($P< 0.01$) in the intestinal motility in a dose- dependent manor, that is directly correlated to its volumes and concentrations. It is demonstrated in previous studies that coffee stimulate gastrin release and gastric acid secreation[27]. Also drinking coffee can stimulate a motor response of the distal colon and perceived to soften stools in normal people[28]. Moreover, ferulic acid that is presented in coffee extract significantly accelerated the gastrointestinal transit and gastric emptying in rats in a dose- dependent manor[29]. This effect may help to improve gastrointestinal symptoms such as abdominal discomfort and also may protect against emesis. However, those with constipation may seek coffee as a relief for their symptoms because of its laxative effect[16].

Conclusion:

The green and red tea extracts induced a significant dose-dependent Inhibition of contractions and relaxations of the jejunal smooth muscle , on the contrary, coffee extract , shows a significant increase of jejunal motility in a dose-dependent manor, while the black tea extract dose not show any noticeable effect on spontaneous jejunal activity. The tea extract that reduce intestinal contraction has a potential use in diarrhea.

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دراسة مختبريه لتأثير مستخلصات الشاي الأخضر والأحمر والأسود ومستخلص القهوة على حركة العضلات الملساء لأمعاء اللبائن

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الخلاصة:-

يعد الشاي الشراب الأكثر استهلاكا في العالم حيث يحتوي على مواد فعالة مثل الكافيين وحامض التانيك واحتواءه على مواد مضادة للتقلصات, بينما تعتبر القهوة شرابا عالي الحامضيه ويحتوي على أعلى مقدار من الكافيين. في هذه الدراسة حاولنا بحث تأثير مستخلصات أنواع الشاي الأخضر والأحمر والأسود ومستخلص القهوة على تقلص وانبساط العضلات الملساء لأمعاء الأرنب في محاولة لاستكشاف بعض الاستعمالات الطبية لها.

تم اخذ قطع من المعي المعزولة فصلت من أمعاء الأرنب وغمرت في محلول التايرود الذي يحتوي على نفس مكونات السائل الخلوي من جسم الأرنب , وتم إضافة أحجام وتراكيز مختلفة من مستخلص الشاي الأخضر والأحمر والأسود والقهوة عليها وتسجيل استجابة العضلات الملساء للأمعاء بوساطة جهاز حوض الأعضاء المعزولة . أدى كل من مستخلص الشاي الأخضر والأحمر إلى كبح التقلصات التلقائية لعضلات الأمعاء بشكل يتناسب مع حجم وتركيز المستخلص بينما لم يظهر مستخلص الشاي الأسود أي تأثير يذكر على الحركة التلقائية للعضلات الملساء وبالمقابل اظهر مستخلص القهوة زيادة ملحوظة في مدى تقلص العضلات الملساء وبشكل يتناسب مع الحجم والتركيز.