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CLINICAL STUDY

The effect of inhaling peppermint odor and ethanol in women athletes

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Abstract: The purpose of this study was to determine whether inhaling peppermint odor has effects on time of running, maximum heart rate (MHR), maximum oxygen consumption (VO_2max), oxygen consumption (VO_2), minute ventilation (VE) and respiratory exchange ratio (RER) during acute intensive exercise or not. 36 women soccer player were chosen for participating in this research. They were randomly divided in 3 groups (control, inhaling peppermint, inhaling mixture of peppermint and ethanol). In order to be aware of similarity of groups, the subjects' BMI was determined and ANOVA did not show any significant differences ($p<0.05$). The subjects of three groups ran on treadmill according to Bruce test. Heart rate, time of running, VO_2max, VO_2, VE and RER were measured by Gas Analyzer. After collecting the data, ANOVA was done ($p<0.05$) and the results showed that in this study the inhaling of fragrant odors did not have any significant effect on the time of running, MHR, VO_2max, VO_2, VE and RER, which we think is due to the intensity and duration of training.
Referring to our results of the present study; we suggest that inhaling peppermint odor during acute intensive exercise has no significant effect on pulmonary indexes and physical performance *(Tab. 4, Fig. 1, Ref. 21).* Full Text (Free, PDF) *www.bmj.sk.*
Key words: peppermint odor, VO_2max, VO_2, minute ventilation.

Nowadays in sport competitions, the least time, the most power and prolonging the time of reaching exhaustion are some important points that affect the success. Apart from regular exercise training and sufficient nutrition, the athlete's performance can be improved by some permissible supplementations (14). Common examples include carbohydrate supplementation, caffeine ingestion and blood doping in order to enhance endurance performance. Sodium bicarbonate loading is recognized for its potential ergogenic effect on sprinting events. Creatine supplementation and anabolic steroids have been reported in lay and scientific publications as a means of increasing strength and endurance (14, 17). Carbohydrate supplementation is allowed before and during competition. Caffeine is also allowed, however urinary concentration cut-offs of 12 mcg/mL [Untied States Olympic Committee] and 15 mcg/mL [National Collegiate Athletic Association] prohibit its massive dosages before competition [Allen and Hanbury, 1992] Blood doping, [a process of reinfusion of blood after extraction followed by 3 weeks of training to increase ones hematocrit and hemoglobin levels] and anabolic steroids [simulation of testosterone to increase skeletal muscle] are banned due to medical and ethical reasons (Wilmore and Costill, 1998). Creatine supplementation is allowed with no established guidelines due to the lack of literature addressing its effects in both, short term and long term. Aromatherapy, another possible ergogenic aid, has been growing in recent years and has received much attention by both traditional and alternative medicine practitioners (14, 18). A series of studies has recently begun to emerge focusing on the ability of odors to influence mood (9, 13, 18). Raudenbush et al (2004) found that some smell stimulants such as peppermint odor, jasmine and dimethyl sulfide did not have any significant effect on cardiovasculary performance (heart rate and oxygen consumption) in student athletes (12). Also recent studies have shown that inhaling some odors such as peppermint can affect the performance capacity (aerobic and anaerobic) (3). Menthol has been used for many years in a wide range of over-the-counter medications. As a medicine, its most popular application is in the relief of common cold symptoms such as cough and chest congestion, although there is very little objective clinical evidence to show that menthol has any beneficial effects at the levels used in proprietary cough and cold products (21). Cohen & Dressler (1982) have studied the effects of a mixture of aromatic vapors (including menthol) on the calibre of

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airways in volunteers suffering from common cold. By measuring the forced expiratory volumes (FEV1), peak expiratory flow rate, and lower as well as total airways resistance, an improvement in airway's calibre with a 20–60 min aromatic vapor inhalation was found (4). Wright et al (1997) reported that menthol significantly decreased the airways resistance following an injection of Capsaicin (21). By its definition, peppermint could be considered a substance that can enhance physical and mental capacities (14). Inhaling peppermint is reported to stimulate an increase in energy, which any athletic or non-athletic individuals would certainly benefit of during an exercise bout (2). As a matter of fact, only few research studies have been conducted to accept or refuse this (13). Moreover, previous research studies investigated the effect of inhaling fragrant odor on chronic exercise whereas in acute intensive exercise, the main system for producing energy is the anaerobic system. Due to the lack of studies in the latter area we have chosen to focus on the effect of inhaling fragrant odor during one bout of intensive exercise and this is the reason why our study is unique.

Material and methods

Subjects

36 elite women soccer players were randomly divided in 3 groups. None of the subjects had respiratory disorders, allergic history; and during this study none of them used any medicinal drugs. All subjects were familiar with exercise protocols and walking on a motorized treadmill. Following the explanation of risks and benefits associated with participation, the subjects signed the written consent statement.

The characteristics of subjects are shown in Table 1.

Instrumentations

Breath by breath pulmonary gas exchange

For measuring breathing gases and VO_2max, Gas Analyzer (model: K4b2, COSMED, Italy) was used. After calibration, and setting special masks on subjects' faces they began to run on the treadmill according to Bruce process. During the test and until the end of the test, these masks remained on their faces. The instrument collects and analyzes breathing gases automatically and records the results per second. This instrument can analyze Rf, VT, VO_2, O_2exp, CO_2exp, VE/VO_2, VE/VCO_2, VO_2/kg, RER, %FeO_2, %$FeCO_2$, HR, VO_2/HR, %$FetO_2$, %$FetCO_2$, Env.Temp, Anyz.Temp, Analyz.Press, Env.Press, PRO%, FAT%, CHO%, nPRQ, METS.

Body Composition

For analyzing subjects' body compositions we used Body Composition Analyzer (model: In body 3.0, Finland).

Peppermint essence

Peppermint is a plant, which can grow in most areas with different climate. This plant has different species such as menthe crepue, sauge officinale, betoine officinale, serpolet and thym commun (20). Peppermint plant is a part of herbal drugs which has antibacterial property that can be used in treatment of cold, laryngitis, bronchitis, cough, whooping-cough (20). It can also be used for relaxation of active muscles. Inhaling the essence of this plant can be useful in treatment of asthma (20). The plants of this family can support digestion and decrease mental stress and fatigue (10).

The effective materials of peppermint odors

Peppermint essence contains menthol that is the most important substance of this plant and contains almost 50 % of this essence. Methyl ester, manthon, thymol-2Isopropyl-5methylphenol and carvacrol-5Isopropyl-2methylphenol are the other substances in this essence. Menthol is produced from thymol-2Isopropyl-5methylphenol artificially and can be useful in treatment of rheumatoid arthritis.

For producing the peppermint essence for this study, 100 gr fresh leaves of peppermint plant (menthe piperita) was collected from Iranian National Research and Technology network for

Tab. 1. The characteristic of subjects.

*	Age (yre)	Height (cm)	Weight (kg)	Heart rate (bpm)	Free fat mass (kg)	Percent of fat mass (percen tage)	Body mass index (BMI)
control	21.50± 1.65	161.65 ± 6.94	59.96 ± 9.69	75.20 ± 6.75	41.04	25.1	22.78
Peppermint essence	21.85 ± 4.02	161.90 ± 5.82	58.42 ± 8.02	77.08 ± 9.68	42.35	24.47	21.09
Mixture of peppermint and ethanol	20.23 ± 3.03	157.15 ± 5.36	53.29 ± 8.27	79.38 ± 6.70	38.85	26.93	21.625
total	21.17 ± 3.15	160.12 ± 6.24	56.87 ± 8.76	77.39 ± 7.88	40.75	25.51	22.10

*Results are expressed as mean± standard deviation

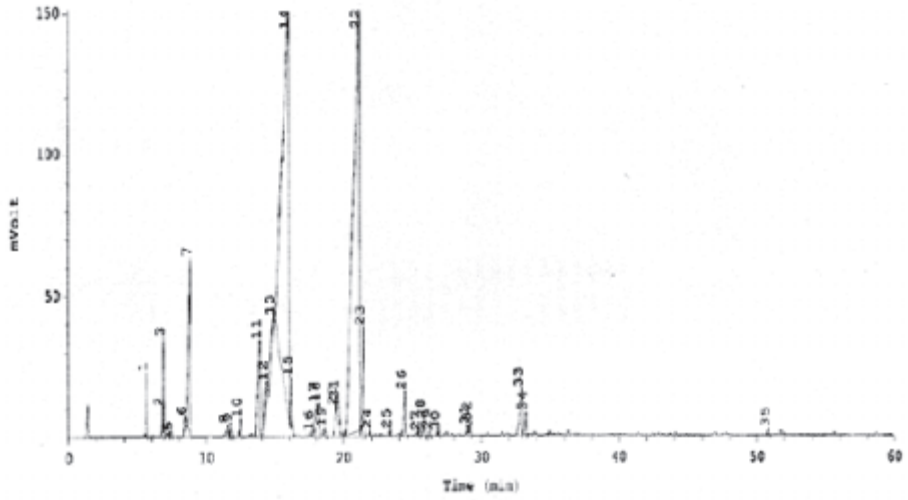

Fig. 1. The result of peppermint chromatography.

medicinal plants (NRTN-MP). At first it was analyzed with gas chromatograph machine (CG,model:shimadzu), then the essence was produced in an hour (Fig. 1 and Tab. 2).

Procedures

Prior to data collection, subjects were familiarized with the laboratory setting and the mask that was used for collecting the expired gases during each trial. In order to assess each subject's olfactory sensation, they were asked to identify three recognizable aromas: coffee, apple and a placebo [water with food coloring]. As subjects confirmed their olfactory sensation by recognizing each aroma, their suitability for participation was confirmed. Oxygen consumption [VO_2], maximum oxygen consumption [VO_2max], minute ventilation [VE] and respiratory exchange ratio [RER] were obtained via breath by breath pulmonary gas exchange [Gas Analyzer]. HR was recorded using a Polar Heart Rate Monitor. A motorized treadmill [Technogym model: via G.perticaria,20,47035 Gambettola(Forli), Italy] was used for the exercise mode. However the aroma was administered in a double-blind crossover design.

After acclimation to the laboratory of national Olympic committee, subjects rested for 15 minutes for measuring the resting heart rate. Then subjects' values of body composition were measured. Afterwards 2 drops (0.1 ml) of essence or the mixture of essence and alcohol or placebo (aquapura) were set on a sterile cotton pad by using a scaled pipette. The cotton pad was then set under the nose of each individual. Subjects inhaled the aroma only by nose breathing. When the special masks of Gas Analyzer (collecting expired gases) were set on individuals' faces, they were asked to begin the protocol of study, namely to run on treadmill according to Bruce protocol. The speed of treadmill was 1.6 km/hr and slope of 10 % degree. At every three-minute interval, speed and slope were increased to reach an acute intensive exercise program. RPE (Rate of perceived exertion) was obtained using the modified Borg scale. Heart rate was recorded per minute during the test.

In order to prevent effective factors, all of the measurements were done by a technician who had not been present at the trials and the measurements were performed at the same location and time. In point of fact, we wanted to demonstrate the truthfulness of the hypotheses that inhaling the peppermint odor during acute intensive exercise could affect the maximum heart rate, VO_2max, VO_2, minute ventilation, time of running and respiratory exchange ratio.

Tab. 2. The result of peppermint chromatography (Menthapippereta)

PK NO	RT	PERCENTAGE	RI	
1	5. 650000572	0. 7047	940. 8512	α Pinene
2	6. 766666889	0. 2914	976. 0522	Sabinene
3	6. 900000572	0. 8761	979. 8607	β Pinene
4	7. 266667366	0. 0456	989. 9663	3-P-Menthene
5	7. 433333874	0. 1104	994. 3923	2-Octanal
6	8. 483333588	0. 2598	1020. 181	
7	8. 816667557	4. 8476	1027. 7033	Limonene
8	11. 53333378	0. 165	1100. 8877	
9	11. 73333454	0. 172	1106. 1608	
10	12. 41666698	0. 2951	1123. 5221	
11	13. 58000134	3. 0258	1157. 0283	Menthone
12	14. 35000134	0. 3844	1167. 9056	
13	14. 86666775	0. 2687	1178. 7543	Terpin-4-ol
14	15. 95000076	39. 5927	1200. 3271	Trans-dihydrocarvone
15	16. 13333511	0. 5962	1203. 8324	Cis-pulegol
16	17. 66666794	0. 0979	1231. 6788	
17	18. 01666832	0. 1345	1237. 6956	Prlgone
18	18. 16666794	0. 2438	1240. 2386	Carvone
19	18. 60000038	0. 1315	1247. 4686	
20	19. 40000153	0. 0989	1260. 3844	
21	19. 53333473	0. 3985	1262. 4852	
22	21. 1166687	41. 8145	1313. 5545	Neoiso-isopulegol acetate
23	21. 40000153	1. 9875	1320. 196	
24	21. 91666794	0. 069	1332. 0835	
25	23. 35000229	0. 0848	1363. 6504	
26	24. 41666794	0. 8542	1385. 9087	
27	25. 43333435	0. 0564	1406. 2366	
28	25. 83333588	0. 2273	1414. 0125	
29	26. 25000191	0. 0737	1421. 9854	
30	26. 88333511	0. 0544	1433. 865	
31	29. 00000191	0. 1436	1471. 6305	
32	29. 16666794	0. 1707	1474. 4861	
33	32. 8666687	1. 2657	1580. 5311	
34	33. 18333435	0. 3821	1587. 9868	
35	50. 83333588	0. 0754	2067. 8029	

Tab. 3. Maximum and minimum treadmill time in Bruce test

	Inhaling peppermint	Inhaling peppermint and ethanol	Control group
Minimum time(minute)	9.47	8.3	7.28
Maximum time(minute)	11.18	11.15	10.45

Statistical analysis

Means and standard deviations were calculated for all variables. For comparing the effects of inhaling the peppermint odor and the mixture of peppermint and ethanol on dependent variable, independent one-way ANOVA was used. Before these analyses were performed, the frequency distributions were tested for normality using the Kolmogrof-Smirnov test. The level of significance was set at (p•0.05).All analyses were run by SPSS for Windows.

Results

Table 3 demonstrates the data obtained from analysis of expired gases.

The first result of this research shows that the inhaling of peppermint essence and mixture of peppermint and ethanol couldn't incur significant differences between groups in maximum heart rate during one bout of acute intensive exercise in women athletes [F=2.08, df=35, α=0.05].

Other results of this investigation showed no significant differences between groups.

Brief results of this research are shown in Table 4.

Discussion

Previous findings indicate that peppermint odor can enhance the physiological aspect of athletic performance (Raudenbush et al, 2001), but the result of the present study did not show any significant differences between groups. It is obvious from literature that there are vast differences in opinions regarding the efficacy, validity and overall claims towards the role of aromatherapy in all aspects of medicine, particularly preventative and rehabilitative medicine. Exercise does not fall into both, preventative and rehabilitative categories and therefore the use of aromatherapy in concert with exercise is quite popular.

The amount and the way of using the essence that can make significant differences, enhance energy and improve athletic performance are not clearly distinguished.

The fact that in present study, the inhalation of peppermint odor and mixture of peppermint and ethanol did not affect the maximum heart rate significantly during one bout of exercise is in accord with similar results of Goubault et al, Simpson et al and Raudenbush researches (8) (12) (14). In this study, the heart rate during acute intensive exercise in all three groups was increased but there are no significant differences between groups in response to exercise. Martin reported that an exposure to odor of spearmint was associated with a significant reduction in EEG theta when compared with no-odor control (reduction in EEG theta means more relaxation). Based on this result of pervious study, we expected the inhaling groups to have lower heart rate when compared with control group. The fact that the results do not confirm this can be a response to the intensity of exercise exerted in this study. May be these data are disappointing regarding aromatherapy and exercise performance, however when paying attention to the intensity and duration of exercise, these results are understandable. Simpson et al (2001) and Welker and co-workers (1998) found similar results.

After comparing the means of VO_2max, VO_2 and minute ventilation of groups it was obvious that in $p<0.05$ there was no significant difference between groups. This finding is similar to the result of Norris and Welker et al who studied the effect of ambient odor on physiological values as well as to those of Simpson et al and Goubault et al who studied the effect of aromatherapy on exercise (8, 10, 14, 18, 19).

Researchers believe that many factors can affect the results of this type of studies. The length of exercise bout may have affected the results. A bout of exercise lasting 12–14-minutes may be not adequately sufficient for peppermint stimulants to exert their effect on heart rate response and physiological values. Further, it is not known what mechanisms play a key role with aromatherapy and metabolism. When the duration of exer-

Tab. 4. Brief results of present study

variation	Control	Peppermint	Peppermint + ethanol	α	Significant differences
MHR(bpm)	194.77 ± 6.38	183 ± 19.19	187 ± 6.91	0.071	NS
VO2max	29.25 ± 3.03	31.54 ± 5	31.20 ± 5.19	0.404	NS
VO2	1788.50 ± 232.06	1700.23 ± 286.17	1628.85 ± 260.74	0.369	NS
Minute ventilation(L/min)	92.39 ± 10.43	92.07 ± 9.01	86.30 ± 15.10	0.371	NS
Time of running(s)	535.10 ± 78.74	593 ± 6298	560.23 ± 74.23	0.167	NS
RER	1.87 ± 0.21	1.72 ± 0.23	1.82 ± 0.18	0.865	NS
RPE	17 ± 0.94	17.08 ± 2.22	18.23 ± 1.01	0.102	NS

*Results are expressed as mean± standard deviation

cise bout is short, the ambient odors will show no significant differences (Simpson et al, 2001). There is almost no evidence of the effect of menthol on human body. Cohen and Dressler (1982) have studied the effects of a mixture of aromatic vapors (including menthol) on the caliber of airways in volunteers suffering from common cold. The measurement of forced expiratory volumes, peak expiratory flow rate and lower as well as total airways resistance showed an improvement in internal diameter of airways.

Raudenbush believes that inhaling the peppermint odor during acute intensive exercise has no significant effect on respiratory physiological values and in some previous researches it improves performance by enhancing the mood and motivation.

Some researchers believe that ambient odor can affect the physiological aspects of performance but Raudenbush mentioned that during athlete's performance at maximum level, the presence of ambient odor had little effects on physiological values. Lis – Balchin has reported that peppermint odor has a sedative effect on smooth muscle in vitro; it is unknown in what other condition peppermint odor might exert sedative effect on human body. Peppermint oil was found to reduce the amplitude of the potential dependant calcium current and increase the rate of the current's decay. This is a similar effect to that observed with menthol in neuronal preparations (Swandulla et al, 1986, 1987). Researchers hypothesize that menthol may have a similar mechanism of action in bronchial smooth muscle as those in ileal smooth muscle and neuronal preparations, namely that it acts upon cell membranes by regulating Ca^{2+} efflux. The effect of menthol upon sensory afferents or other neuronal elements is possible; through this, menthol has multiple effects, but there is no document proving the direct effect of menthol on bronchial smooth muscle.

The result of present study about RPE shows a little increase in inhaling groups in accord with similar result of Simpson et al (2001). RPE is a good index for evaluating individual's effort during an exercise bout (ACSM, 1995). Researchers mentioned that inhaling ambient odor can affect the performance in both positive and negative ways, and the peppermint essence increases concentration and improves performance. Other researchers mentioned that audient and olfactory stimuli during exercise may block the unsatisfactory feedbacks from the environment to the central nervous system and enhance relaxation of individuals (Broadbent, 1958).

So be that as it may, it seems better to use inhaling ambient odor during training time or cycle of an athlete to achieve significant effects on physiological aspects of performance.

In this study, our result is similar to those of Welker et al, Buckle et al, Goubault et al who examined the effect of inhaling salbotamol on time of running in 12 healthy professional non-smoker athletes, and Raudenbush et al (12, 19).

Researchers have found no significant effects of glucose and lipids on plasma concentrations and CNS activity after using substances such as salbotamol, They have also reported that salbotamol and salmetrole do not have any ergogenic effects. Other researchers believe that ambient odors can improve mood and since mood and motivation are closely related, the increase in mood may also bring about an increase in motivation. With an increase in motivation, athletes are likely to exert more effort. However, should an athlete be not skilled in technique, the enhancement of motivation cannot improve his or her performance.

The results of this study indicate that inhaling a peppermint essence or mixture of peppermint essence and ethanol cannot bring about significant differences when compared to the control group. After 15 minutes of acute intensive exercise, an average individual is just beginning to achieve the true point at which the oxygen demands equal the oxygen availability. The latter point is more commonly referred to as the steady state of oxygen consumption. By paying attention to reported RER, fat metabolism has not yet begun to contribute significantly as an energy source. RER at 0.9 indicates that 33 % of fat is being consumed for energy whereas at 0.95 only 17 % of fat is being consumed. It is possible that aroma may have more beneficial effects when fat is the major fuel source as opposed to carbohydrate.

The length of the exercise bout may have affected the results (Tab. 3). Welker and co-workers (1998) also found no effect on physiological values, so Simpson suggests that given a longer exercise bout and perhaps different exercise intensities, the effect of aroma may be more evident. Further research should explore the relationship of aroma with exercise bouts up to 120 minute and intensities varying from as low as 40 % of VO_2max, which would equate walking, up to 70 % of VO_2max, which would equate moderate running speeds. These varying conditions will appropriately reflect the habits of more individuals with different degrees of exercising intensities.

Conclusion

The results of the present study demonstrate that the inhaling of peppermint essence or mixture of peppermint essence and ethanol during acute intensive exercise has no beneficial effect on physiological performance of athlete. This may be due to some factors such as intensity and length of exercise or the amount and content of essence that was used in this study. It seems that also the results of previous studies were affected by these factors. Therefore in order to be sure about the effect of aromatherapy on physiological performance we suggest that further research with different intensities and lengths of exercise as well as amount of essence are to be conducted. In an age when athletic competitions can be won or lost by mere hundredths of a second, athletes are continuously looking for new ways to excel in their sport.

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