

# Randomised clinical trial: dried plums (prunes) vs. psyllium for constipation

A. Attaluri, R. Donahoe, J. Valestin, K. Brown & S. S. C. Rao

Division of Gastroenterology/  
Hepatology, Department of Internal  
Medicine, University of Iowa Carver  
College of Medicine, Iowa City, IA,  
USA.

## Correspondence to:

Dr S. S. C. Rao, Division of Gastro-  
enterology/Hepatology, Department  
of Internal Medicine, University of  
Iowa Hospitals and Clinics, 200  
Hawkins Dr, 4612 JCP, Iowa City,  
IA 52242, USA.  
E-mail: satish-rao@uiowa.edu

## Publication data

Submitted 5 September 2010  
First decision 1 October 2010  
Resubmitted 30 December 2010  
Accepted 18 January 2011  
EV Pub Online 15 February 2011

## SUMMARY

### Background

Treatment of chronic constipation remains challenging with 50% of patients dissatisfied with current therapy. There is an unmet need for natural and safe alternatives. Dried plums (prunes) have been used traditionally for constipation but their efficacy is not known.

### Aim

To assess and compare the effects of dried plums and psyllium in patients with chronic constipation.

### Methods

Subjects were enrolled in an 8-week, single-blind, randomised cross-over study. Subjects received either dried plums (50 g b.d., fibre = 6 gm/day) or psyllium (11 g b.d., fibre = 6 gm/day) for 3 weeks each, in a crossover trial with a 1-week washout period. Subjects maintained a daily symptom and stool diary. Assessments included number of complete spontaneous bowel movements per week, global relief of constipation, stool consistency, straining, tolerability and taste.

### Results

Forty constipated subjects ( $m/f = 3/37$ , mean age = 38 years) participated. The number of complete spontaneous bowel movements per week (primary outcome measure) and stool consistency scores improved significantly ( $P < 0.05$ ) with dried plums when compared to psyllium. Straining and global constipation symptoms did not differ significantly between treatments ( $P = N.S.$ ). Dried plums and psyllium were rated as equally palatable and both were safe and well tolerated.

### Conclusion

Dried plums are safe, palatable and more effective than psyllium for the treatment of mild to moderate constipation, and should be considered as a first line therapy.

*Aliment Pharmacol Ther* 2011; **33**: 822–828

## INTRODUCTION

Constipation is a common problem that affects up to 20% of the world's population. Nearly 60 million Americans suffer from chronic constipation.<sup>1</sup> The prevalence of constipation is higher in women and in adults over the age of 65 years.<sup>1</sup> It significantly affects quality of life, and leads to a loss of work productivity and abstinence from school.<sup>2, 3</sup> Only about one-third of constipated patients seek medical care,<sup>2</sup> and many patients self-treat their symptoms either by increasing fibre intake or by using over-the-counter laxatives. Recently, it has been recognised that constipation involves multiple symptoms and not merely reduced stool frequency. Constipation is a 'functional bowel disorder that presents with persistent, difficult, infrequent, or incomplete defecation, which do not meet IBS criteria', and with less than three bowel movements (BMs) per week.<sup>4, 5</sup>

Treatment of constipation continues to evolve and remains challenging. In a recent survey of over 5000 patients who were taking medications for constipation, nearly one half of patients were dissatisfied with current therapy.<sup>6</sup> When consulted for management, initial therapy included recommendations for lifestyle modifications such as adequate fluid intake and nonstrenuous exercise, increased natural fibre intake, and dedicated time for BMs. However, the evidence to support these measures is rather weak.<sup>7</sup>

Traditional methods to treat constipation include bulking agents (psyllium, methylcellulose), stool softeners (docusate sodium), stimulant laxatives (senna, bisacodyl), osmotic laxatives (milk of magnesia, lactulose, sorbitol) and polyethylene glycol (PEG). Recent systematic reviews have concluded that there is good evidence to support the use of psyllium but not other OTC laxatives or fibre supplements.<sup>8, 9</sup> Compared with placebo, psyllium appears to increase stool frequency in some but not all of the studies.<sup>8, 9</sup> A large study that compared psyllium with placebo showed significant improvement in both stool frequency and stool consistency; and both the investigator and patients noted significant improvement in constipation.<sup>10</sup>

However, patients often find fibre supplements inconvenient, particularly during travel, and many dislike liquid preparations. Finally, the taste of fibre supplements, the occurrence of gas or bloating, and rarely choking are often reasons for lack of compliance or discontinuation of therapy.<sup>11</sup>

Consequently, there is a need for a food-based, natural, convenient and tasty alternative to the currently available OTC laxatives and fibre supplements. Dried

plums (prunes) and prune juice have been traditionally used for the treatment of constipation,<sup>12</sup> but dried plums have not been systematically assessed in patients with well defined constipation. Also, the efficacy, palatability and tolerability of dried plums in the treatment of chronic constipation are not known.

We hypothesised that dried plums are as effective as psyllium in the treatment of adults with chronic constipation. Our aims were to investigate and compare the effects of dried plums and psyllium on bowel symptoms as well as taste, and tolerability in adults with chronic constipation in a randomised crossover controlled trial.

## METHODS

### Subjects

Subjects between the ages of 18 and 75 years and with symptoms of chronic constipation were enrolled. Patients were included if they had symptoms for  $\geq 3$  days/month for the past 3 months and reported at least two of the following symptoms  $\geq 25\%$  of the time (ROME III):<sup>4, 5</sup> straining, lumpy or hard stool, sensation of incomplete evacuation, sensation of anorectal obstruction/blockage, use of manual manoeuvres,  $\leq 3$  BMs/week.<sup>4, 5</sup> Also, they had insufficient criteria for irritable bowel syndrome, and only rarely experienced loose stools without using laxatives. We excluded patients with alarm features such as weight loss, rectal bleeding, recent change in bowel habit ( $< 3$  months), abdominal pain and those whose stool was positive for occult blood and those with co-morbid illnesses such as severe cardiovascular disease, chronic renal failure, or those with previous gastrointestinal surgery except cholecystectomy and appendectomy. We also excluded patients with neurologic diseases such as multiple sclerosis, stroke, spinal cord injury, Hirschsprung's disease, or active local anorectal problems such as anal fissure, bleeding haemorrhoids, or patients with alternating constipation and diarrhoea, or those using fibre supplements, laxatives, PEG, tegaserod or lubiprostone or those unwilling to discontinue these medications at least 2 weeks prior to the study. Subjects with suspected difficulty with defecation (use of digital manoeuvres, history of faecal impaction, frequent use of enemas) or known pelvic floor dysfunction (based on anorectal manometry, ballon expulsion test) were excluded from the study. However, subjects were not required to undergo testing for pelvic floor dysfunction prior to enrolment in the study. All subjects were recruited from the community through local advertisement, and the study was approved by the University of Iowa institutional review board.

### Study design

Subjects were enrolled into a 14-week, randomised cross-over study with blinded data analysis. A flowchart is shown in Figure 1. All subjects underwent comprehensive clinical evaluation and were instructed to discontinue laxatives or other medications for constipation for at least 1 week prior to study enrolment. Subjects were asked to maintain their usual lifestyle including diet and physical activity during the study period and to report any changes to the study investigators. During the 1-week run-in period, subjects maintained a daily stool and symptom diary. After the run-in period, if considered eligible, subjects were randomised to receive either dried plums (California Dried Plums, Sacramento, CA, USA) (50 g twice a day with meals) or psyllium (Metamucil, Proctor and Gamble Pharmaceuticals, Mason, Ohio) (11 g with 8 oz of water twice a day) for a treatment period of 3 weeks. Subjects maintained daily symptom and stool diaries. Subjects were instructed to use bisacodyl suppositories (5 g) as rescue laxatives, if they had no BM for 3 days and up to a maximum of 2/week, and its use was documented on the stool diaries. After the first treatment period, subjects discontinued all therapy for a washout period of 1 week. Subsequently, subjects were crossed over to receive either dried plums or psyllium for a treatment period of 3 weeks. After completion of therapy, subjects were asked to continue with their usual remedies for constipation and return for a follow-up visit at 6 weeks. Subjects were asked to keep a stool diary during this 6-week period.

The amount of dietary fibre in 50 g of dried plums is 3 g. Likewise, the amount of dietary fibre in 11 g of psyllium is 3 g. Consumption of dried plums at a dose of 50 g twice a day (about 12 plums) is considered a reasonable serving for consumers, and one tablespoon of

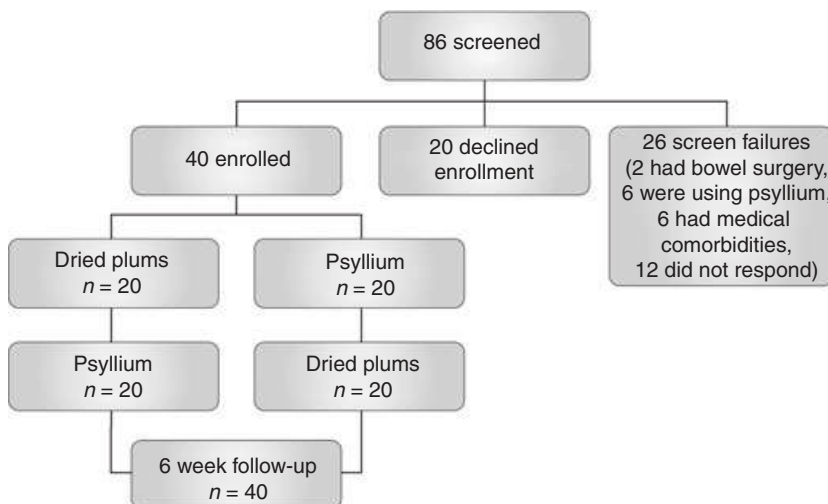
psyllium twice a day has been used in previous clinical trials.<sup>8, 9</sup> Dried Plums are also commonly described as 'prunes' in Europe and elsewhere.

### Measurements

All subjects maintained a daily stool and symptom diary during the 8-week study period and for 1 week before their final 6-week follow-up visit. In addition, at the end of each treatment period, subjects were asked to fill out a global constipation symptom score. This validated Rome III outcome measure rated current constipation-related symptoms on a seven-point Likert scale (−3 = markedly worse, −2 = somewhat worse, −1 = a little bit worse, 0 = no change, +1 = a little better, +2 = somewhat better, +3 = markedly better) when compared to baseline symptoms. At the end of each 3-week treatment period, subjects were also asked to rate the taste of the product that they had just consumed on a visual analogue scale (0 = worst, 10 = best). Finally, subjects were asked to rate the presence of three common symptoms, satiety, postprandial fullness, and abdominal bloating/distension and rate its severity on a visual analogue scale (0 = no symptoms, 10 = severe symptoms). The data were abstracted and analysed by the authors, who were blinded to the treatment group allocation. Only one author (JV) was unblinded to subject allocation and did not participate in data analysis.

### Data analysis

The primary outcome measure was the effect of treatment on the mean number of complete spontaneous bowel movements (CSBMs) per week. The secondary outcome measures were; global constipation symptom score, taste survey scores, stool consistency (Bristol stool form scale, 1–7), straining score (rated from 1 = mild to 3 = severe). In addition, the number of BMs/week, the



**Figure 1** | Diagram showing study enrollment and reasons for screen failure.

number of spontaneous bowel movements (SBMs) per week (no laxative/enema in preceding 24 h), and the number of complete bowel movements (CBMs) per week (sensation of complete evacuation) were also assessed from the stool diaries.

The stool diary data (number of BMs, SBMs, CBMs and CSBMs, stool consistency and straining effort) were compared between the 1-week baseline period and the last (third) week of treatment with either psyllium or dried plums using two-tailed paired Student's *t*-test with Welch's correction for unequal variances and one-way analysis of variance. Taste, fullness, bloating and satiety scores were compared with two-tailed paired Student's *t*-test. Negative binomial regression analysis was performed to assess the order effect for each of the primary and secondary outcome measures.

**Sample size assessment.** The CSBM data from our previously published study<sup>13</sup> was used to calculate the sample size. In a crossover design, in order to detect a difference of 1 CSBM/week between the treatment groups, 38 subjects were needed at 80% power and at 0.05 significance level. Assuming a potential dropout rate of two subjects, a sample size of 40 subjects was considered to be adequate for this study.

**RESULTS**

**Demographics and baseline stool characteristics**

Eighty six subjects with constipation were screened and from this group 40 subjects (*m/f* = 3/37, mean

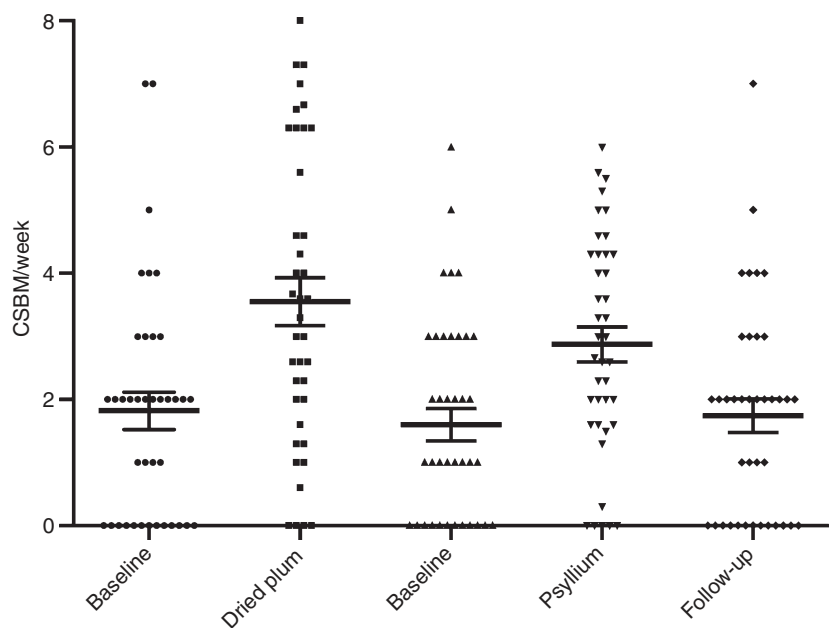
age = 38 years) were enrolled (Figure 1). The median duration of constipation symptoms was 2 years (range: 6 months to 35 years). Of the 38 subjects who were employed, seven (18%) reported missing at least 1 h of work/week due to constipation-related symptoms.

The baseline CSBM/week (mean ± S.E.M.) was 1.7 ± 0.3, and the stool consistency was 2.7 ± 0.1 and the straining score was 1.2 ± 0.2.

**Effect of psyllium and dried plums on stool characteristics**

The mean number of CSBM/week was significantly higher during dried plum treatment than during psyllium treatment (3.5 ± 0.2 vs. 2.8 ± 0.2, *P* = 0.006; Figure 2). When compared to the pre-treatment baseline (run-in and wash-out period), treatment with both dried plums and psyllium led to a significant increase in CSBMs/week (1.8 vs. 3.5, *P* = 0.001 and 1.6 vs. 2.8, *P* = 0.001). At 6-week follow-up, the CSBM rate decreased to 1.8/week. Similarly, BM/week, SBM/week and CBM/week were each significantly higher during dried plum therapy than during psyllium therapy (Table 1).

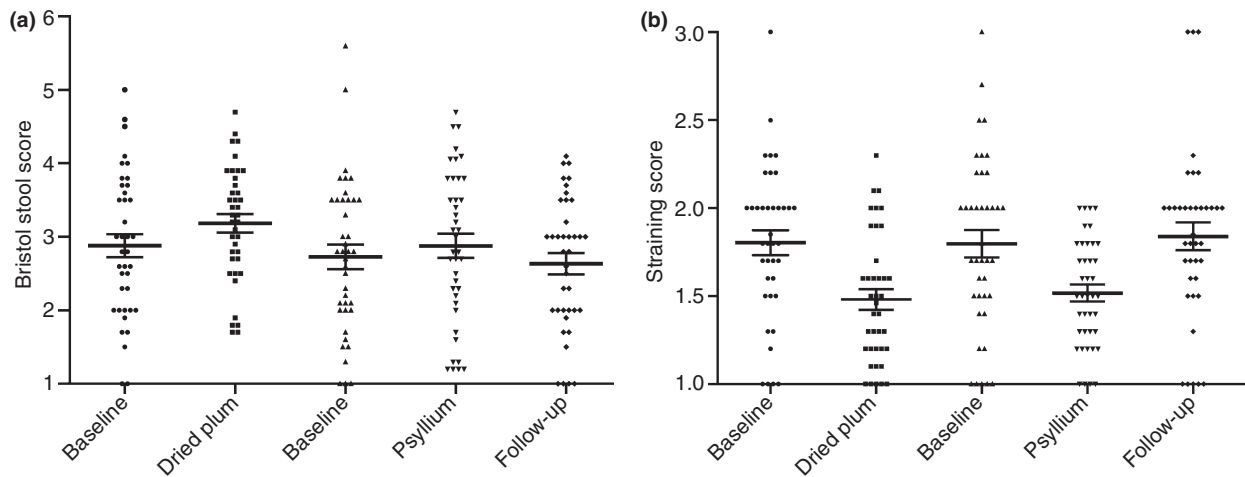
Dried plums produced softer stool when compared to psyllium. Stool consistency score was higher with dried plums when compared to baseline and when compared to psyllium therapy (3.2 vs. 2.8, *P* = 0.02; Figure 3). At baseline and at 6-week follow-up, most subjects had hard stools (mean score 2.7). Mean straining scores with dried plums and psyllium were similar (1.4 vs. 1.5, *P* = 0.5) but improved significantly (*P* < 0.05) from baseline (Figure 3).



**Figure 2 | Complete spontaneous bowel movements per week at baseline, during dried plum and psyllium treatment and at follow-up.**

**Table 1** | Effects of dried plums and psyllium on the number of complete bowel movements (CBMs) per week, spontaneous bowel movements (SBMs) and bowel movements (BMs) at baseline, and during treatment and at 6-week follow-up (mean ± S.E.M.)

	Baseline	Dried plums	Baseline	Psyllium	Follow-up	P-value (dried plums vs. psyllium)
CBMs/week	2.8 ± 0.3	3.6 ± 0.4	2.7 ± 0.2	2.9 ± 0.3	2.5 ± 0.3	0.001
SBMs/week	4.1 ± 0.4	6.5 ± 0.4	3.8 ± 0.4	5.4 ± 0.3	3.5 ± 0.4	0.04
BMs/week	4.4 ± 0.4	6.8 ± 0.5	4.1 ± 0.4	5.7 ± 0.6	4.4 ± 0.5	0.002



**Figure 3** | Stool consistency (a) (Bristol stool from scale) and straining score at (b) baseline, during dried plum and psyllium treatment and follow up.

**Overall constipation symptoms**

On the global constipation symptom survey, 28 (70%) subjects who received dried plums and 22 (55%) subjects who received psyllium reported improvement of symptoms and rated their improvement as at least ‘somewhat better’ (+2) when compared to baseline symptoms. The mean global constipation symptom scores were 1.7 and 1.3 respectively, for dried plum and psyllium and there was no difference ( $P = 0.1$ ).

**Palatability and tolerability**

Subjects rated both dried plums and psyllium as palatable with mean taste scores of 6.5 and 6.4 respectively, and there was no difference between the two supplements ( $P > 0.5$ ). Satiety scores were also similar with dried plums and psyllium (8 vs. 8.1,  $P > 0.5$ ). Also, scores for postprandial fullness (5.2 vs. 5.4) and bloating (4.1 vs. 3.5) were similar and there was no difference between the supplements ( $P > 0.1$ ).

**Use of rescue laxative and adverse effects**

Three (8%) subjects used either bisacodyl or enemas once during treatment with dried plums and psyllium respectively. One subject used another OTC laxative preparation (magnesium) during dried plum treatment. No adverse effects were reported during the study. Nineteen subjects used laxatives or stool softeners during the 6-week follow-up period (seven used dried plums, four used psyllium, three used enemas, three used bisacodyl, one used PEG, one used methylcellulose).

**Order effect**

Negative binomial regression analysis did not show any significant interaction between the order of treatment and the primary and secondary outcome variables (Table 2). Therefore, the order of treatment did not have an effect on the outcomes. Also, primary and secondary outcome variables returned to the pre-treatment baseline during the washout period.

**Table 2** | Order effect data, mean (inter quartile range, IQR)

	Order	Dried plum median (IQR)	Psyllium median (IQR)
BM/week	Dried plums-psyllium	8.20 (7.02, 9.59)	7.34 (6.42, 8.39)
	Psyllium-dried plums	8.35 (7.37, 9.46) <i>P</i> = 0.72	7.47 (6.53, 8.56) <i>P</i> = 0.82
Stool consistency	Dried plums-psyllium	3.09 (1.59, 4.59)	2.59 (1.02, 4.14)
	Psyllium-dried plums	3.05 (1.55, 4.62) <i>P</i> = 0.49	2.87 (1.32, 4.21) <i>P</i> = 0.15
Straining	Dried plums-psyllium	1.88 (1.08, 2.68)	1.82 (1.02, 2.63)
	Psyllium-dried plums	1.62 (0.98, 2.33) <i>P</i> = 0.74	1.66 (0.94, 2.42) <i>P</i> = 0.82

## DISCUSSION

In this prospective, randomised-controlled trial, we found that treatment with dried plums resulted in a greater improvement in constipation symptoms as reflected by a significant increase in the number of CSBMs and in stool consistency (softer stools) when compared to treatment with a commonly used fibre supplement, psyllium. Also, more subjects reported subjective improvement in overall constipation symptoms, although the mean global constipation symptom scores were similar. Thus, dried plum therapy (prunes) resulted in improvement of objective parameters of bowel function such as the number of CSBM/week as well as subjective features of constipation. These findings confirm the general notion that dried plums that are widely consumed can be useful for the treatment of constipation.

In this study, we assessed the number of CSBMs as opposed to measuring stool frequency (number of BMs/week) alone, because the latter provides incomplete information regarding the overall bowel function and constipation. Furthermore, constipation is a heterogeneous condition that includes difficulty with defecation such as hard stool, excessive straining and feeling of incomplete evacuation as well as infrequent BMs. Hence, we believe that CSBM is a better and more robust measure of overall bowel function in constipation. This is further attested by its use in several large randomised controlled trials of both drug and behavioural therapies for constipation.<sup>13, 14</sup> We found that both treatments produced a significant increase not only in the number of CSBMs/week when compared to the baseline period, but also in the number of BMs/week and SBMs/week. These findings suggest that both treatments are effective in the treatment of mild constipation, although dried plums were superior. A higher proportion of patients also reported that subjectively they felt better during

treatment with dried plums than with psyllium but the difference was not significant ( $P < 0.05$ ).

Our results are in agreement with another recent study which compared plum juice with psyllium.<sup>12</sup> However, unlike our study in which we used prospective stool diaries and assessed the number of CSBMs/week, the previous study used retrospective recall of BMs as their primary outcome measure. It is well known that there is significant recall bias and significant overestimation of BMs by constipated patients.<sup>15</sup> Also, because of the unblinded nature of their study, there may have been a higher degree of responder bias.<sup>12</sup> Furthermore, we conducted a follow-up assessment and found that stool frequency and stool consistency returned to the prestudy baseline levels, suggesting that the improvements observed during the study were due to the treatments and not a placebo effect or observational bias.

The laxative effects of dried plums are most likely due to a combination of sorbitol (14.7 g/100 g), dietary fibre (6 g/100 g), and polyphenols (184 mg/100 g), although the exact mechanism has not been established. Sorbitol acts as an osmotic laxative and holds on to water. The dietary fibre in plums is water soluble and it is also present in prune juice. Since we tested an equivalent dose of dietary fibre, it is likely that the clinical improvement observed with dried plums is most likely due to the other beneficial components of plums over and above its fibre content and/or the blend of soluble and insoluble fibre in this compound.

We also assessed the palatability and tolerability of plums. Our subjects rated both plums and psyllium as quite palatable and there was no difference between the two treatments. Also, in this study we did not observe any significant adverse effects such as those reported with other studies of fibre, notably gas and bloating. This could be due to the fixed dose of fibre or twice a day

usage or the type of fibre supplements that were used in this study. A recent multinational survey of adults with constipation identified lifestyle changes and dietary supplements as the preferred first intervention for constipation.<sup>16</sup> Given their palatability, tolerability and availability, dried plums should be considered in the initial approach to the management of mild to moderate constipation in the general population.

Our study shows that psyllium was also useful in improving bowel symptoms in patients with mild to moderate constipation and is in agreement with prior studies on psyllium in chronic constipation.<sup>17, 18</sup> Whether these benefits persist in the long term is not known. The limitations of our study include the smaller sample size, crossover design and the potential of crossover effect, although this was minimised by a washout period. Although we recruited subjects with chronic constipation from the community who fulfilled the Rome III criteria, most of them had mild to moderate degree of symptoms, unlike patients seen in tertiary care referral centres. Also, it should be noted that subjects with severe constipation or those refractory to laxatives or those with possible dyssynergic defecation (pelvic floor dysfunction) were not included in this study.

In conclusion, our randomised controlled study demonstrates that treatment with dried plums is efficacious and appears to be better than treatment with psyllium for the relief of bowel symptoms in adults with chronic constipation. In addition, dried plums are safe and palatable. Our findings suggest that this natural product should be considered as a first line therapy for chronic constipation.

## ACKNOWLEDGEMENTS

*Declaration of personal interests:* Ashok Attaluri was involved in grant writing, subject recruitment, data analysis and manuscript writing. Rachel Donahoe was involved in subject recruitment, study conduct and data entry. Jessica Valestin was involved in subject recruitment, study conduct, data entry and verification and study coordination including IRB and grant contracts. Kice Brown was involved in statistical analysis. Satish SC Rao was involved in study concept, grant writing, subject recruitment, study supervision, data analysis and manuscript writing. *Declaration of funding interests:* This study is supported by an unrestricted research grant from the California Dried Plum Board.

## REFERENCES

- Higgins PD, Johanson JF. Epidemiology of constipation in North America: a systematic review. *Am J Gastroenterol* 2004; **99**: 750–9.
- Dennison C, Prasad M, Lloyd A, Bhattacharyya SK, Dhawan R, Coyne K. The health-related quality of life and economic burden of constipation. *Pharmacoeconomics* 2005; **23**: 461–76.
- Rao SS, Seaton K, Miller MJ, et al. Psychological profiles and quality of life differ between patients with dyssynergia and those with slow transit constipation. *Psychosom Res.* 2007; **63**: 441–9.
- Longstreth GF, Thompson WG, Chey WD, et al. Functional bowel disorders. *Gastroenterology* 2006; **130**: 1480–91.
- Bharucha AE, Wald A, Enck P, Rao S. Functional anorectal disorders. *Gastroenterology* 2006; **130**: 1510–8.
- Johanson JF, Kralstein J. Chronic constipation: a survey of the patient perspective. *Aliment Pharmacol Ther* 2007; **25**: 599–608.
- Muller-Lissner SA, Kamm MA, Scarpignato C, Wald A. Myths and misconceptions about chronic constipation. *Am J Gastroenterol* 2005; **100**: 232–42.
- Ramkumar D, Rao SS. Efficacy and safety of traditional medical therapies for chronic constipation: systematic review. *Am J Gastroenterol* 2005; **100**: 936–71.
- Brandt LJ, Prather CM, Quigley EM, et al. Systematic review on the management of chronic constipation in North America. *Am J Gastroenterol* 2005; **100**(Suppl. 1): S5–21.
- Fenn GC, Wilkinson PD, Lee CE, Akbar FA. A general practice study of the efficacy of Reglan in functional constipation. *Br J Clin Pract* 1986; **40**: 192–7.
- Schiller LR. Review article: the therapy of constipation. *Aliment Pharmacol Ther* 2001; **15**: 749–63.
- Cheskin LJ, Mitola AH, Ridoré M, et al. A naturalistic, controlled, crossover trial of plum juice versus psyllium versus control for improving bowel function. *Internet J Nutr Wellness* 2009; **7**(2).
- Rao SS, Seaton K, Miller M, et al. Randomized controlled trial of biofeedback, sham feedback, and standard therapy for dyssynergic defecation. *Clin Gastroenterol Hepatol* 2007; **5**: 331–8.
- Johanson JF, Wald A, Tougas G, et al. Effect of tegaserod in chronic constipation: a randomized, double-blind, controlled trial. *Clin Gastroenterol Hepatol* 2004; **2**: 796–805.
- Ashraf W, Park F, Lof J, Quigley EM. An examination of the reliability of reported stool frequency in the diagnosis of idiopathic constipation. *Am J Gastroenterol* 1996; **91**: 26–32.
- Wald A, Scarpignato C, Kamm MA, et al. The burden of constipation on quality of life: results of a multinational survey. *Aliment Pharmacol Ther* 2007; **26**: 227–36.
- Ashraf W, Park F, Lof J, et al. Effects of psyllium therapy on stool characteristics, colon transit and anorectal function in chronic idiopathic constipation. *Aliment Pharmacol Ther* 1995; **9**: 639–47.
- McRorie JW, Daggy BP, Morel JG, et al. Psyllium is superior to docusate sodium for treatment of chronic constipation. *Aliment Pharmacol Ther* 1998; **12**: 491–917.