Prunes Across the Lifespan
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• Shirin received her doctorate from the Department of Nutrition, Food and Exercise Sciences at Florida State University where she studied the bone reversal effects of plants’ bioactive compounds.

• She completed her post-doctoral training at Florida State University working in the area of nutrition, bone and cartilage.

• Her current research interests include bone and calcium metabolism, osteoporosis and osteoarthritis, and functional foods.

• She has served as an ad hoc reviewer for the USDA’s small business innovation research (SBIR) grants for the Food Science and Nutrition program and as a reviewer for VA musculoskeletal/orthopedic rehabilitation grants.

• She is the Medical and Scientific Advisory Board member of American Bone Health (ABH) and an ambassador for National Osteoporosis Foundation (NOF).

• She was an invited faculty for the Interdisciplinary Symposium on Osteoporosis (ISO2014) organized by the National Osteoporosis Foundation and an invited speaker for the 10th International Symposium on Nutritional Aspects of Osteoporosis (ISNAO2017).

• She has published 40 original articles in peer reviewed journals and presented more than 90 abstracts at national and international symposia.

• She has received the Graduate Women in Science (GWIS) fellowship, the Florida State University Graduate Research and Creativity Award and the Florida State University Alumni award.
Shirin Hooshmand, PhD, RD

Disclosures:
- Dr. Hooshmand is a research consultant for Sunsweet Growers Inc.
- Research support provided by the California Dried Plum Board
How the Bones Change:

- Build
- Maintain
- Prevent

Bone loss, falls and fractures

- Rapid Bone Building
- Peak Bone Mass
- Menopause

Photo: American Bone Health
Bone Mineral Accrual During Adolescence

- Boys
  - Age at peak: 14.05 years
  - Peak value: 409 g/year
  - Size adjusted value: 394 g/year

- Girls
  - Age at peak: 12.54 years
  - Peak value: 325 g/year
  - Size adjusted value: 342 g/year

Bailey et al., J Bone Miner Res, 1999
Bone Health At Every Age

Peak Bone Mass:

➤ As kids grow, their bone mass increases until they achieve “Peak Bone Mass”.

➤ The greatest amount of bone that you can attain.

➤ Kids and teens with higher Peak Bone Mass may have a lower risk of osteoporosis later in life.

Boys: average peak at age 14 years*
Girls: average peak at age 12.5 years*

*Bailey et al., J Bone Miner Res, 1999
Photo: National Osteoporosis Foundation
Determinants Of Peak Bone Mass

- Genetics
- Gender
- Mechanical Forces
- Hormones
- Risk Factors
- Nutrition

Rizzoli et al., Bone, 2010
**Fig. 1.** Diagrammatic representation of the bone mass life-line in individuals who achieve their full genetic potential for skeletal mass and in those who do not. (The magnitude of the difference between the curves is not intended to be to scale.) Along the bottom of the graph are arrayed several of the factors known to be of particular importance. (© Robert P. Heaney 1999, used with permission.)
Bone Composition

Matrix
- 90% Collagen
- 10% noncollagenous

Organic 33%
Inorganic 67%

Ca 39%
P 17%
K 0.2%
Na 0.7%
Mn 0.1%
Influence of Peak Bone Mineral Mass on Osteoporosis

Hernandez et al., osteoporosis Int., 2003
What about during Pregnancy and Lactation?

- During pregnancy and lactation, female physiology adapts to meet the added nutritional demands of fetuses and neonates.
- An average full-term fetus contains:
  - 30 g calcium,
  - 20 g phosphorus, and
  - 0.8 g magnesium
- About 80% of mineral is accreted during the third trimester.
- Calcium transfers at 300-350 mg/day during the final 6 wk
- Fetal demand for calcium and phosphorus has the potential to provoke maternal hypocalcemia and hypophosphatemia.

The neonate requires:
- 200 mg calcium daily from milk during the first 6 mo, and
- 120 mg calcium from milk during the second 6 mo (additional calcium comes from solid foods).

How about women who nurse twins and triplets?
- Calcium transfer can be more than double and triple above values!

Kovacs et al., 2016
Longitudinal changes in calcium, phosphorus, and calcitropic hormone levels during human pregnancy

Shaded regions depict the approximate normal ranges.

Kovacs et al., 1997 and 2016
Bone Loss During Pregnancy and Lactation / Kalkwarf and Specker

There are case reports of pregnancy-associated osteoporosis, and it has been suggested that this pathologic condition either is a transient failure of the usual calcitropic hormonal changes that usually occur during pregnancy, or occurs in women with preexisting osteopenia (11,12). Investigation of typical changes in bone density during pregnancy has been hampered by concern regarding exposure of the fetus to radiation associated with dual X-ray absorptiometry measurement. To circumvent this, investigators either have limited bone density measurements to peripheral skeletal sites during pregnancy so that the fetus is not exposed to additional radiation, or have obtained baseline measurements before pregnancy and follow-up measurements shortly after delivery. Several longitudinal studies have found loss of bone density during pregnancy. Reported losses range from 2 to 2.6% at the ultradistal radius (13,14), 2 to 4% at the spine (8,15,16), and 2.4 to 3.6% at the hip (8,17). Other studies have not found bone density changes during pregnancy, possibly because of small sample sizes or long intervals between baseline measurement and pregnancy (4,5,18,19). One study found that bone density at trabecular-rich sites (pelvis and spine) decreased by 3 to 4% during pregnancy, whereas bone density at cortical sites (arms and legs) increased by 2% (16).

Some studies have used quantitative ultrasound, which does not involve radiation, to estimate bone density at peripheral skeletal sites during pregnancy. Ultrasound measures of speed of sound (SOS), broadband ultrasound attenuation (BUA), and other indices utilizing these measures are correlated with bone density measurements (20). However, other investigators have found poor correlations and speculated that ultrasound measures properties of bone other than density (21,22). Studies that obtained ultrasound measurements of the os calcis or phalanges throughout pregnancy found decreases in ultrasound measures, particularly in the last trimester when the transfer of calcium to the fetus is the greatest (Fig. 1) (23–26). The magnitude of decrease varied among studies, depending on the follow-up interval and type of measure, ranging from 1.2 to 10.8%. Aguado et al. (26), in a study of 40 women, found that the decrease was greater for women whose calcium intake was <1 g/d, whereas no relationship between bone changes and calcium intake was found in a larger longitudinal study of 230 women (27). Sowers et al. (27) found that nulliparous women and adolescents who were still growing during pregnancy had the largest decreases in ultrasound indices. Growth and increases in body weight during pregnancy, and how the resultant increase in bone loading may modify bone changes have not been described.

Bone lost during pregnancy appears to be regained over the 12–24 mo postpartum. The magnitude of bone gain postpartum is comparable with that lost during pregnancy. Among women who do not breast feed their infants, reported increases in bone density by 6 mo postpartum range from 0.9 to 2.0% at the distal radius (18,28) and 0.4 to 1.4% at the lumbar spine (28,29). At 12 mo postpartum, increases of 1.1% at the distal radius (28), 2.0–2.1% at the lumbar spine (28,29), 1.8% of total body, and 2.9% at the trochanter (30) have been found. Hopkinson et al. (31) found continued bone mineral accretion in the second year postpartum so that by 24 mo postpartum, lumbar spine bone mineral density (BMD) was 2.8% higher and total body bone mineral content was 2.3% higher than at 2 wk postpartum. Since there were no nonpostpartum control subjects, it is not clear what portion of this gain was the result of a normal age-related bone increase. Laskey et al. (30) measured bone mass over a 12-mo period in 11 nonlactating postpartum women and 22 women of reproductive age who had not been pregnant. They found an increase in total body and trochanteric bone mass among postpartum women, but no significant change in bone mass among nonpostpartum women.
Mean percentage change from baseline in total-body and regional BMD after pregnancy
Markers of Formation and Resorption during Pregnancy

Biochemical Markers of Resorption During Normal Pregnancy

Biochemical Markers of Formation During Normal Pregnancy

FIG. 2. (A) Urinary fPyr cross-links during pregnancy. (B) Urinary fDPyr during pregnancy. (C) Urinary NTx during pregnancy.

RESULTS

Free Pyr (fPyr) and free DPyr (fDPyr) cross-links in urine increased during pregnancy compared with the prepregnancy value. Paired T-test was used to compare the difference made during pregnancy compared with the prepregnancy value. Significant increases in IGF-1 were observed at 28–38 weeks gestation (p<0.01) and these changes appeared to precede the changes in the bone formation markers (Fig. 3).

Total alkaline phosphatase (TAP) concentration increased throughout pregnancy as did the bone formation markers. There would be a dissociation of bone formation and resorption with bone resorption predominating in early pregnancy and we have been able to confirm and quantify noninvasively the stimulation of osteoblast activity, which indicates that there is a dissociation of bone formation and resorption.

Bone resorption predominates in early pregnancy and we have been able to confirm and quantify noninvasively the stimulation of osteoblast activity, which indicates that there is a dissociation of bone formation and resorption.

Liver function tests were unaltered except for a change in albumin with a significant decrease throughout pregnancy reflecting the well-known hemodilution effect.
Longitudinal Changes in Calcium, Phosphorus, and Calciotropic Hormone Levels During Lactation and Post-Weaning Skeletal Recovery in Women

Normal adult values are indicated by the shaded areas.
Longitudinal Concentrations of Calciotropic, Estrogen and Prolactin Hormones for Lactating Subjects and Non Lactating Postpartum Subjects
Responses to Acute Estrogen Deficiency Alone Vs. Lactation

ESTROGEN DEFICIENCY

↑ RESORPTION

↑ Ca²⁺ LOSS

(BLOOD)  ↓ PTH  ↔

LACTATION

↑↑ RESORPTION

↓ Ca²⁺ LOSS

(BLOOD)  ↓ PTH  ↔

↑ Ca²⁺ LOSS

PTHrP
Breast-Brain-Bone Circuit

GnRH  ↓  LH, ↓ FSH
        ↓
OT  PRL

↓ E₂, ↓ PROG

Ca²⁺  Ca²⁺  Ca²⁺
PThrp  CT
Calcium and Bone Mass

HIP FRACTURE annual rates/10,000 women

AGE

Low calcium district

High calcium district
Effect of Calcium Supplementation and Lactation on Mean (± SE) Percentage Change in BMD of Lumbar Spine During First 6 Months Postpartum

![Graph showing the effect of calcium supplementation and lactation on BMD change over 6 months postpartum. The graph compares nonlactating and lactating groups with calcium and placebo treatments.]
Major Sites of Osteoporotic Fractures in Postmenopausal Women
Aging and Vertebral Bone

Young Normal

Elderly
Effect of Prunes on Lumbar Spine Bone Mineral Density (Prevention Study)

![Graph showing the 4th lumbar BMD (g/cm³ bone volume) for different groups: Sham, Ovx, LD, HD. Bars represent mean±SE. Bars that do not share the same letters are significantly (p<0.05) different from each other.]

Bars represent mean±SE. Bars that do not share the same letters are significantly (p<0.05) different from each other.
Effect of Prunes on Lumbar Spine Bone Mineral Density (Reversal Study)

Bars represent mean±SE. Bars that do not share the same letters are significantly (p<0.05) different from each other.
Effect of Prunes on Microstructure of the Trabecular Bone

Sham

OVX

LD

MD

HD

E₂
Effects of Prune Consumption by Postmenopausal Women on Bone Biomarkers

- ALP
- B-ALP
- IGF-1
- Dpd
- HP

Dried Apple
Dried Plum

BMD Changes From Baseline After One Year Consumption of Prune or Dried Apple

Bar represents mean ± SD. Significantly different at p<0.05 between treatment groups.
Annual Percentage Change in Bone Mineral Density (BMD)

<table>
<thead>
<tr>
<th>Change in BMD (%/y)</th>
<th>Femoral Neck</th>
<th>Lumbar Spine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Premenopausal</td>
<td>Perimenopausal</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>-0.5</td>
</tr>
<tr>
<td>-0.5</td>
<td>-0.5</td>
<td>-1.5</td>
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<tr>
<td>-1</td>
<td>-1</td>
<td>-2</td>
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<td>-1.5</td>
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<td>-2.5</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
<td>-3</td>
</tr>
</tbody>
</table>

Macdonald et al. 2004
Effects of Prune Consumption by Postmenopausal Women on C-Reactive Protein

Bar represents mean ± SD. Significantly different at p<0.05 between treatment groups.

Hooshmand et al., Br J Nutr, 2011
Lower Dose of Prune?

Calcium and Vitamin D

Calcium and Vitamin D + 50g/d Prune

Calcium and Vitamin D + 100g/d Prune

SIX MONTHS

= Blood draw, questionnaires including medical history, diet history, physical activity and food frequency questionnaire

= Bone density measurement (DXA Scan)
Lower Doses: BMD Changes From Baseline After Six Months Consumption of Prune

Bar represent mean±SE. = Different from 0 g (Control; *P<0.05).
Bone Mineral Density Five Years Following One-Year Intervention

(A) Areal BMD (g/cm² Bone Volume)

(Dried Plum) vs (Dried Apple)

(B) Areal BMD (g/cm² Bone Volume)

(Dried Plum) vs (Dried Apple)
Antioxidant Quality of Prunes

Comparison of quality of antioxidants of vitamins and dried fruits (mean ± SD).

Vinson et al., The J Am Coll Nutr, 2005
Percent Changes in Vertebral BV/TV with Dried Fruit Treatments
Alterations in Plasma Glutathione Peroxidase Activity (GPX) with Dried Fruit Treatments

Figure 3. Alterations in Plasma Glutathione Peroxidase Activity (GPx) with Dried Fruit Treatments.

Another plausible mechanism by which the dietary treatments may have affected bone quality is through alterations in osteoblast and osteoclast activity. For example, the expression of caspase-3 and caspase-9, which are involved in the apoptotic process, was down-regulated in response to OVX or dietary treatments. This suggests that dried plum supplementation results in enhanced bone formation and reduced bone resorption.

Table 4. Biomechanical Properties of Trabecular Bone in the Lumbar Vertebra and Proximal Tibia.

<table>
<thead>
<tr>
<th></th>
<th>Sham</th>
<th>O VX-Control</th>
<th>O VX-Plum</th>
<th>O VX-Apple</th>
<th>O VX-Apricot</th>
<th>O VX-Grape</th>
<th>O VX-Mango</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Force (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Stiffness (10^3 N/m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size Independent Stiffness (N/m)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Comparisons of plasma GPx in sham-operated (Sham) and ovariectomized (OVX) mice fed control diet, or control diet supplemented with either 25% (w/w) dried plum, apple, apricot, grape, or mango for 8 weeks. Values are means ± SE, n = 8 mice in each group. Bars that share the same superscript letter are not significantly different (p < 0.05).
Dietary Prune Increases Bone Mass: Promotes Attainment Of Peak Bone Mass

Shahnazari et al., J Nutr Biochem., 2016
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>New DRI</th>
<th>% in dried plums</th>
<th>% in prune juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving (g)</td>
<td>100</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>Available carbohydrate (g)</td>
<td>130</td>
<td>33.2</td>
<td>32.4</td>
</tr>
<tr>
<td>Total dietary fiber (g)</td>
<td>38</td>
<td>18.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Ca (mg)</td>
<td>1300</td>
<td>3.3</td>
<td>2.4</td>
</tr>
<tr>
<td>K (mg)</td>
<td>4700</td>
<td>15.6</td>
<td>15.0</td>
</tr>
<tr>
<td>Fe (mg)</td>
<td>18</td>
<td>5.2</td>
<td>16.8</td>
</tr>
<tr>
<td>Mg (mg)</td>
<td>420</td>
<td>9.8</td>
<td>8.6</td>
</tr>
<tr>
<td>P (mg)</td>
<td>1250</td>
<td>5.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Cu (mg)</td>
<td>0.9</td>
<td>31.2</td>
<td>19.3</td>
</tr>
<tr>
<td>Mn (mg)</td>
<td>2.3</td>
<td>13.0</td>
<td>16.8</td>
</tr>
<tr>
<td>Se (μg)</td>
<td>55</td>
<td>0.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Zn (mg)</td>
<td>11</td>
<td>4.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Vitamin A (RAE)</td>
<td>900</td>
<td>4.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>90</td>
<td>0.7</td>
<td>11.7</td>
</tr>
<tr>
<td>Vitamin E (mg α-tocopherol)</td>
<td>15</td>
<td>2.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Vitamin K1 (μg)</td>
<td>120</td>
<td>49.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Thiamin (B1) (mg)</td>
<td>1.2</td>
<td>4.3</td>
<td>3.4</td>
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<tr>
<td>Riboflavin (B2) (mg)</td>
<td>1.3</td>
<td>14.3</td>
<td>13.8</td>
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<tr>
<td>Niacin (mg)</td>
<td>16</td>
<td>11.8</td>
<td>12.6</td>
</tr>
<tr>
<td>Pantothenic acid (mg)</td>
<td>5</td>
<td>8.4</td>
<td>5.5</td>
</tr>
<tr>
<td>Vitamin B6 (mg)</td>
<td>1.7</td>
<td>12.1</td>
<td>32.8</td>
</tr>
<tr>
<td>Folate (μg)</td>
<td>400</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Choline (mg)</td>
<td>550</td>
<td>1.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Note: DRI – highest RDA or adequate intake (AI), except in pregnancy or lactation.
Prunes are a convenient snack with an added nutrient value.

- Economical and portable
- No need for refrigeration
- 4 to 5 prunes are only 100 calories
not, depending upon the assay used. The low values of carotenoids, ascorbic acid, and vitamin E point to their high content of phenolic compounds as the contributing factor. Yet their phenolic content cannot explain all of their antioxidant capacity.

TWO AREAS OF INVESTIGATION THAT HAVE BEEN A FOCUS OF CDPB FUNDING

The NAP recommended to the CDPB that they focus on particular areas of research and seek to develop the science in those areas. In retrospect, 2 areas have received the most intense funding. Gastrointestinal (GI) health, for obvious reasons, and bone health, which became an important area serendipitously. These studies are reviewed here with the objective that the reader sees the progression and type of studies funded, how other investigators not funded by CDPB become interested, and how paying close attention to the type of study needed as evidence leads to an official health claim.

GI Effects

Dried plums/prunes have been the subject of many a joke, especially in the United States. Seeking to reposition the fruit away from the jokes and to younger consumers, the CDPB applied to the FDA for a formal name change to dried plum in 2001, which was approved. Surprisingly little research has been published on the effect of dried plum or prune juice on GI function. There are 3 components of dried plum that could affect GI motility: sorbitol, dietary fiber, and phenolic compounds. The sorbitol content of dried plum (10–12 g/100 g or 2 servings) is uniquely high and is equivalent to consuming 12 sticks of sugarless gum or individual candies that can act as an osmotic laxative in high quantities.

Whether one is affected by consuming high levels of sorbitol is highly variable and seems to be related to the ability to absorb it. Breath hydrogen studies indicated that 71% of healthy adults showed malabsorption after consuming 10 g of sorbitol and 20% reported symptoms of bloating, flatulence, and abdominal pain. However, a dose of pure sorbitol would enter the lower GI tract at a faster rate than found in an equivalent dose of whole dried plums. Those with irritable bowel syndrome have a greater likelihood of having a lower absorption potential.

Phenolic compounds are also thought to have an effect on GI motility. Sorbitol has Generally Recognized As Safe (GRAS) status and GRAS sets limits for percent that can be contained in specific food items but does not set a human limit. Very old references from 2 small studies find that ~20 g of pure sorbitol can produce diarrhea.

| TABLE 2 Antioxidant Compounds and Major Secondary Metabolites in Dried Plums and Prune Juice |
|-----------------------------------------------|----------------|----------------|
| Serving size | Dried Plum | Prune Juice |
| 100 g (~11 dried plums) | 100 g (>1/3 cup) | |
| Total carotenoids, mg | 0.43 | – |
| Total chlorogenic acids, mg | 108–153 | 19–102 |
| Neochlorogenic acid, mg | 91–133 | 56 |
| Cryptochlorogenic acid, mg | 31–51 | 38 |
| Chlorgenic acid, mg | 7–10 | 8 |
| Galic acid, mg | 2 | – |
| Caffeic acid, mg | 2.6 | – |
| Proanthocyanidins, mg | 62 | – |
| Cyanidin, mg | 0–2.4 | – |
| Delphinidin, mg | 0–0.2 | – |
| Quercetin, mg | 0–4.0 | – |
| Ascorbic acid, mg | 0.3 | 10.5a |
| Vitamin E, mg | 0.2 | 0.3 |

From Stacewicz-Sapuntzakis.7

aAscorbic acid is added to prune juice.
Children: ranging from 0.7% to 29.6%
Adults: ranging from 2% to 35%
Constipation accounts for 2.5 million physician visits annually in the United States.
Constipation has a significant impact on quality of life, affecting both physical and emotional well-being.
Pregnancy and Constipation:

- Symptoms:
  - infrequent defecation,
  - hard or scybalous stool,
  - excessive straining

- Constipation affecting about half of women at some point during pregnancy
Studies have shown that 35–40% of older individuals complain of gastrointestinal (GI) problems, most commonly constipation.

Constipation in the elderly has many potential causes, including but not limited to:
- reduced fluid intake
- poor nutrition
- an undesirable effect of medication
Figure 2-1.
Dietary Intakes Compared to Recommendations.
Percent of the U.S. Population Ages 1 Year & Older
Who Are Below, At, or Above Each Dietary Goal or Limit

- Vegetables
- Fruit
- Total Grains
- Dairy
- Protein Foods
- Oils
- Added Sugars
- Saturated Fat
- Sodium

Percent of Population Below Recommendation or Limit vs. Percent of Population Above Recommendation or Limit.
Figure 2-3.
Average Daily Food Group Intakes by Age-Sex Groups, Compared to Ranges of Recommended Intake

Vegetables

Fruits
USDA Choose MyPlate

- Encourages consumers to make half their plates fruits and vegetables
- Encourages intake of nutrients of concern: dietary fiber and potassium
Prunes for the Treatment of Constipation

- Many patients with chronic constipation, which afflicts around 15% of community-dwelling adults are convinced of the importance of food in both causing and relieving their symptoms.

- Recommended first-line therapy is a gradual increase in fiber intake, either incorporated into the diet, or through standardized fiber supplements.
Randomized Clinical Trial: Dried Plums (Prunes) vs. Psyllium for Constipation

A. Attaluri et al., 2011
Complete Spontaneous Bowel Movements Per Week at Baseline, During Dried plum and Psyllium Treatment and At Follow-Up.
Figure 3 | Stool consistency (a) (Bristol stool from scale) and straining score at (b) baseline, during dried plum and psyllium treatment and follow up.
Prunes 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.

Nutrients:
- Fiber
- Sorbitol (14.7 g/day)
- Polyphenols
Digestive Discomfort?

A. Stool Frequency (per week)

B. Estimated Fecal Bulk (cups/week)

C. Consistency of Stool

D. Strain During Bowel Movement

E. Pain During Bowel Movement

F. Feeling of Constipation After Bowel Movement

For each graph, values are least square mean ± SE; n = 20 and 18 for dried apple and dried plum regimens, respectively. Figures 1A through 1F reflect the effects of dried plum and dried apples for 3 months on bowel movement habits. Figures 1A and 1B represent number of bowel movements and amount of stool produced per week, respectively. Figures 1C through 1F are based on a scale of 1 to 7. Figure 1C, 1 being very soft and 7 being very hard; Figure 1D, 1 being none and 7 being extreme straining; Figure 1E, 1 being none and 7 being extreme pain during bowel movement; and Figure 1F, 1 being not constipated and 7 being very constipated. No statistically different responses were observed between time points within each treatment or between treatment groups.

Many factors affect bowel function, one of those factors being fiber intake. Haack et al. reported an increase in dietary fiber from 16 g to 30 g a day, from a variety of food sources, increased frequency of defecation. It has also been reported that dietary fiber increases fecal bulk by 3 to 6 g for each additional gram of fiber consumed. In our study, fiber intake prior to initiation of the study was 19 g/day, which is above the estimated 14 g/day typically consumed by Americans. According to the final food frequency questionnaire, study participants receiving the dried plum and the dried apples increased their fiber consumption by 7 and 5 g/day, respectively. The final fiber intake of 26 g/day for the prune and 24 g/day for the dried apple regimens, are approximately the same level as the adequate intake (AI) of 14 g/1000 calories recommended.
Digestive Discomfort?

We did not observe any significant changes for average estimated faecal bulk between groups at 3 and 6 months. At 6 months, the overall feeling of constipation increased in the control group significantly in comparison to the 100 g dried plum group. Feeling of pain significantly increased in the control group at 6 months compared to the 50 g dried plum group. In addition, at 3 months, the feeling of pain significantly decreased in the 100 g dried plum groups compared to the 50 g dried plum group (Fig. 1A–1F).

* = Different between groups at the same time point (p < 0.05).

Figures 1. A to 1F. For each graph, values are mean ± SD. Figures 1A through 1F reflect the effects of dried plum (0 g, 50 g, and 100 g) for 6 months on bowel movement habits. Figures 1A and 1B represent number of bowel movements and amount of stool produced per day, respectively. Figures 1C through 1F are based on a scale of 1–7.
Prune Juice for Digestive Health

- Prune juice contains fiber and sorbitol, contributing to digestive health.
  - Sorbitol is a sugar alcohol that is minimally absorbed and helps pull water into the small intestine.
  - Fiber plays an important role in the microbiome.
Thank you!