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Health Benefits of Chia — Learn About Its History, Nutrient Composition, and Current Research Regarding Its Health Benefits

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A time is approaching when the word "chia" may not immediately conjure images of clay pots with sprouting green "hair." In the United States, interest in chia, an ancient seed, has risen dramatically in the past several years. Chia advocates claim that due to the seed's high fiber and omega-3 fatty acid content, it can do everything from conquer inflammation and lower cholesterol to aid in weight loss, stabilize blood glucose levels, and boost exercise performance. Does the tiny chia seed live up to its mighty reputation?

This continuing education course provides an overview of chia's history and nutrient composition, reviews current research regarding the health benefits of chia seeds, and offers strategies RDs can use to advise clients about chia seeds.

What Is Chia?

A relative of mint, chia's botanical name is *Salvia hispanica* L.; it's part of the family of *Lamiaceae*, superdivision of *Spermatophyta*, and kingdom of *Plantae*. A flowering annual plant, it produces small white or purple blossoms and can grow up to one meter in height. The common name "chia," derived from a word meaning "oily," was given by the Aztecs and inhabitants of pre-Columbian South and Central America. These populations used chia as a medicinal and staple food.[1,2] Chia is primarily grown for its seeds, which are high in alpha-linolenic acid (ALA)—an omega-3 fatty acid—fiber, protein, minerals, and antioxidants, and are gluten-free. The seeds are small (1 mm to 2 mm), oval-shaped, and may be black, grey, white, or grey or white spotted with black.[2]

Since chia can grow in arid environments, it's been traditionally cultivated and consumed in Central and South America.[2] Today, Argentina, Bolivia, Ecuador, and Peru are the top chia-producing countries.[3] Within the past few years others have entered the fast-growing chia market, including Australia and, most recently, the United States.[4] By late 2012, chia's commodity growth rate was 239%, and the industry's value is predicted to reach $1.1 billion by 2020.[3]

History and Traditional Use

In pre-Columbian times, chia was a major commodity cultivated in Mesoamerica, now Central America and southern Mexico, and prized for its medicinal, culinary, artistic, and religious/cultural uses.[2,5]

Chia was thought to enhance other medicinal treatments for myriad maladies such as eye obstructions; respiratory, obstetric, and gastrointestinal ailments; and various infections.[5] Infusions of whole chia seeds were included in medicinal recipes, and there's evidence that before 1600, the roots of the chia plant were also used to treat respiratory infections.[5] After Spanish colonization began, chia cultivation dropped dramatically, leaving fewer surviving domesticated varieties. However, chia's status as a medicinal plant remained unchanged postcolonization and survives to this day.[5]

The culinary uses of chia were equally diverse and involved the use of whole seeds, seed flour, mucilage, and oil. Often processed in the same manner or together with maize, chia seeds were roasted, ground to produce a flour called chianpinolli, then integrated into tortillas, tamales, and beverages.[5] Chianatoles, beverages made with chia flour, were extremely popular in the 16th century and were part of various cultural events and ceremonies. After colonization, there was a shift from chianatoles to beverages made with whole chia seeds. The seeds were mixed into water flavored with lemon and sugar or juices; this use prevails, and the beverage is referred to as agua de chia ("chia water") and chia fresca.[5]

In art, chia oil was a component of Aztec body paints and was also a base ingredient for lacquers and paints used on clay or gourd vessels. The main modern, nonculinary uses of chia oil include incorporation into cosmetic emollients, lacquers, and some paints.[5] There are few accounts of chia's religious use, especially in post-Columbian times. Chia oil may have been used on the feet and legs of fishermen and aquatic workers, but whether it was a religious association with the patron deity of this population or simply a measure to protect the skin from prolonged contact with water is unclear.[5]

Nutrient Composition

Chia seeds are a rich source of ALA, fiber, minerals, and antioxidants. Unlike flaxseeds, which aren't fully digestible in their whole form and must be ground in order to impart their health benefits, chia seeds may be consumed intact without affecting digestion and absorption of their nutrients. Whole flaxseeds provide ample fiber but often pass through the body undigested, leaving their omega-3s and antioxidants untouched.

By caloric content, chia seeds are 53% fat, 35% carbohydrate, and 12% protein.[6,7] Table 1 provides an overview of the primary nutrients in one tablespoon of whole, dry chia seeds.

TABLE 1

Overview of Major Nutrients in 1 T (7.4 g) Dried Chia Seeds[6,7]

Calories	36
Total fat (g)	2.27
Total monounsaturated fatty acids (g)	0.171
Total polyunsaturated fatty acids (g)	1.751
Alpha-linolenic acid (g)	1.319
Total saturated fatty acids (g)	0.246
Total carbohydrate (g)	3.12
Protein (g)	1.22
Total fiber (g)	2.5
Soluble fiber (g)	0.327
Insoluble fiber (g)	2.219
Calcium (mg)	47
Magnesium (mg)	25
Phosphorus (mg)	64
Potassium (mg)	30
Selenium (µg)	4.1

Fatty Acids

Forty-one percent of chia's calories are from polyunsaturated fatty acids (PUFAs), 4% from monounsaturated fatty acids, and 6.5% from saturated fatty acids.[6] The majority of chia's PUFA content is ALA (75%), the parent omega-3 fatty acid. ALA has 18 carbons and is converted in the body to the 20-carbon EPA and 22-carbon DHA. In humans, this conversion isn't efficient because only a small fraction (<1% to 9%) of ALA is converted to EPA and DHA.[8-11]

To put chia's ALA content in perspective, the recommended Dietary Reference Intake (DRI) for ALA is 1.6 g per day for adult males and 1.1 g per day for adult females.[12] One tablespoon of chia seeds provides 1.32 g ALA, meeting the recommended DRI for women and satisfying nearly 83% of daily ALA needs for men.

Table 2 provides a comparison of ALA, fiber, and protein content between chia seeds, flaxseeds, and walnuts.

TABLE 2

Comparison of ALA, Fiber, and Protein Content of Chia Seeds, Flaxseeds, and Walnuts[6,7]

	CALORIES	ALPHA-LINOLENIC ACID (ALA) (g)	TOTAL FIBER (g)	SOLUBLE FIBER (g)	INSOLUBLE FIBER (g)	PROTEIN (g)
Chia seeds (whole, dried), 1 T (7.4 g)	36	1.319	2.5	0.327	2.219	1.22
Flaxseeds (ground), 1 T (7 g)	37	1.597	1.9	0.573	1.338	1.28
Walnuts (ground), 1 T (5 g)	33	0.454	0.3	0.075	0.260	0.76

Protein

Chia contains 18 amino acids, including all nine essential amino acids.[7] Protein content and PUFA content has been found to vary with temperature; increased temperature resulted in decreased PUFA and protein content.[2] Chia's antioxidant properties may also vary according to environmental and soil conditions.[13]

Fiber

Insoluble fiber is predominant in chia seeds, accounting for approximately 87% of total fiber content, with Klason lignin as a main component. Chia seeds' high fiber content and antioxidant properties are thought to protect the high level of PUFAs they contain. Fiber provides the structural protection and the antioxidant capacity protects the PUFAs from oxidation. Klason lignin is thought to be largely responsible for this by providing the seed's resilient structure.[13]

Chia seeds are hydrophilic; when soaked in liquid, they become plump as a gelatinous mucilage capsule forms around the seed. Soluble fiber represents approximately 13% of chia's total fiber and is predominant in the mucilage. Chia's mucilage doesn't contain pectin, despite its gellike appearance and consistency; instead, it contains polysaccharide chains of neutral sugars.[13]

Antioxidants

In 2008, Reyes-Caudillo and colleagues examined the fiber and antioxidant activity of chia seeds from Sinaloa and Jalisco, two regions of Mexico. Two methods were used to extract the phenolic compounds. Extraction with hydrochloric acid in ethanol produced a hydrolyzed extract, while extraction with ethanol alone produced a crude extract. Both hydrolyzed and crude extracts were tested for antioxidant identification and activity. The major compounds found in both seeds using both extraction methods were the flavonols quercetin and kaempferol. Lower concentrations of phenolic compounds caffeic and chlorogenic acids resided in nonhydrolyzed crude extracts only; the authors theorize that the process of hydrolysis likely destroyed these acids. Chia seeds from both regions showed significant and consistent antioxidant activity in all four assays used in this study.[13]

Salba is a brand of white chia seed produced through selective breeding; it's been used in several research studies, as its composition is standardized.[14,15] According to Vuksan and colleagues, Salba "has a nutrient profile that is approximately 20% higher than generic or

regular Chia."[14] It's unclear whether this claim intends to include higher antioxidant activity as well as ALA, since no independently conducted comparison data have been published verifying Salba's nutrient profile.

Evidence for Health Benefits

At least nine significant studies examining the effects of chia in humans have been published to date. These studies vary in many aspects, including type and duration of intervention, number of subjects, subject demographics, health conditions examined, and the type and form of chia seeds used. Of the nine studies, one used whole seeds only,[16] two did not specify,[17,18] two used both whole and milled/ground seeds,[19,20] three used milled/ground seeds only,[14,15,21] and one used topical chia seed oil.[22] The largest controlled trial had 90 participants and lasted a mere 12 weeks. It's questionable due to the length of the study to determine chia's effects on long-term health. Nonetheless, there are many evidence-based reasons to recommend chia. Following is a summarization of the currently available evidence regarding chia's effects on human health outcomes, including those pertaining to specific diseases and conditions.

Weight Loss and Body Composition

A single-blind randomized controlled trial involving 90 overweight and obese adults examined daily chia supplementation and weight loss, body composition, blood pressure, cholesterol levels, and markers of inflammation, including C-reactive protein (CRP) and several inflammatory cytokines. Subjects consumed either 50 g whole chia seeds (25 g twice per day, providing 19 g total fiber and 8.8 g ALA) or placebo daily for 12 weeks. The placebo was comparable in macronutrients to chia but lower in total fiber and contained no ALA. No significant changes in any measure were found, but the chia group had significantly higher blood levels of ALA (but not EPA or DHA) compared with the placebo group.[16]

Sixty-two overweight or obese postmenopausal women participated in a double-blind randomized controlled trial with a metabolomics approach. The subjects consumed 25 g of whole chia seeds, milled (ground) chia seeds, or placebo once daily for 10 weeks. Weight, body composition, blood pressure, augmentation index (a marker of arterial stiffness), lipid profiles, inflammatory cytokines, CRP, and metabolites were measured pre- and postintervention. No significant outcomes were reported; however, blood levels of ALA and EPA significantly increased (by 58.4% and 38.6%, respectively) in the milled chia group but not in the whole chia or placebo groups.[19] This is one of two studies to directly compare the effects of whole vs milled chia seeds. The second study used Salba brand chia seeds and didn't find differences between the effects of ground and whole Salba.[20]

Type 2 Diabetes and Cardiovascular Risk Factors

A single-blind crossover study examined the effect of supplementation with Salba brand chia seeds on 20 subjects with type 2 diabetes. In crossover studies, all patients receive all treatments and act as their own control subjects. For 12 weeks, subjects were randomly assigned to consume both a supplement and bread made with ground Salba or wheat bran. The chia dose was individualized and ranged from 33 g to 41 g per day; the dose was calculated to be at the level of 15 g per 1,000 kcal, based on subjects' estimated energy requirements. The average Salba dose was 37 g, providing 7 g ALA. Throughout the study,

subjects maintained their usual oral medications, including hypoglycemic, lipid-lowering, or antihypertensive therapies.[15]

Compared with the control phase, during which subjects ate bread made with bran, those consuming bread made with chia experienced a near doubling of both ALA and EPA blood levels and had significantly lower systolic blood pressure; the latter was reduced by 6.3 ± 4 mm Hg. Salba had no significant effects on cholesterol, triglycerides, plasma DHA, fasting insulin, or fasting glucose levels or body weight. Emerging risk factor high-sensitivity C-reactive protein (hs-CRP), a measure of low-grade inflammation, was significantly higher after the control phase than the experimental phase, and von Willebrand factor, a blood clotting protein, was significantly lower after the Salba phase. In addition, after the Salba phase, hemoglobin A1c and fibrinogen levels were significantly reduced compared with baseline, but not with the control treatment.[15] Both von Willebrand factor and fibrinogen have been inversely associated with cardiovascular disease; these become even more relevant for people with diabetes already at greater cardiovascular risk. The authors theorize that Salba's antihypertensive effect was due to its elevation of plasma ALA and therefore an elevation of EPA. EPA, they suggest, may have modified the eicosanoid pathway, leading to a decrease in vasoconstrictive prostaglandin production.

Metabolic Syndrome

In a randomized double-blind parallel arm study, 67 subjects with metabolic syndrome reduced their caloric intake by 500 kcal/day and consumed either a placebo powder or a supplement mixture of 7 g dehydrated nopal cactus (equivalent to 100 g nondehydrated), 4 g chia seeds, 22 g oats, and 32 g soy protein for eight weeks. It wasn't specified whether the chia seeds were ground or whole. All subjects lost weight and reduced waist circumference; however, the supplement group had significant decreases in triglycerides, CRP, and lower insulin area under the curve compared with control treatment. Compared with baseline, the supplement group had a significantly lower percentage of subjects with glucose intolerance (after a two-hour glucose tolerance test). Of note, this study also examined subjects' genotypes and found that subjects with a particular gene variant had greater weight loss and an increase in adiponectin levels at the study's end.[18] As chia was just one of several treatment ingredients, it's not possible to pinpoint chia's contribution to the results of this study. In addition, the dose of chia used (4 g) is considerably smaller than that used in other research investigating chia's health effects.

Postprandial Glycemia and Satiety

A very small double-blind crossover study investigated chia's effects on postprandial glycemia and satiety in 11 healthy, normal-weight adults. After a 10- to 12-hour fast, subjects consumed a test meal of white bread, providing 50 g of available carbohydrates, plus 0 g (control treatment), low (7 g), intermediate (15 g), or high (24 g) levels of ground Salba chia seeds. The ground Salba was baked into the bread.

Blood glucose and appetite were measured in the fasting state and 15, 30, 45, 60, 90, and 120 minutes after the test meal. Compared with control treatment, all levels of Salba consumption significantly decreased mean incremental areas under the curve (iAUCs) and lowered blood glucose levels, albeit the latter reached significance at different time points. An iAUC is a

measure of blood glucose concentration over time. Mean iAUC reductions were 21% for 7 g chia, 28% for 15 g chia, and 41% for 24 g chia. Blood glucose was significantly lower at 60 minutes and 45 minutes for the 15 g and 7 g of chia phases, respectively. For the 24 g chia phase, blood glucose levels were significantly lower at the 60-, 90-, and 120-minute measurements. Satiety ratings also showed significance when compared with control treatment: During the 24 g chia phase, subjects reported significantly lower appetite ratings at 60, 90, and 120 minutes. During the 15 g phase, appetite was significantly decreased at 90 and 120 minutes, and during the 7 g phase at 120 minutes postmeal.[14]

This study suggests that as chia consumption increases, so does its attenuating effect on postprandial glycemia. While these findings appear promising, the small sample size and use of Salba limits the degree to which these results may be generalized. The study's authors note that a decrease in postprandial glycemia may provide an explanation for earlier results, showing a decrease in systolic blood pressure and inflammatory markers in subjects with type 2 diabetes.[14]

In another small study of the same design and including many of the same investigators, both whole and ground Salba chia seeds were used to examine postprandial glycemia in 13 healthy subjects. Salba was baked into white bread at low (7 g), intermediate (15 g) and high (24 g) levels in both whole and ground form. Unlike the previous study, the three control breads were matched to the test breads in total calories, fat, and protein using egg whites and margarine. Blood glucose iAUCs were significantly reduced compared with control at all levels of chia supplementation. iAUCs were significantly reduced by 20%, 28%, and 35% for low, intermediate, and high chia doses, respectively. There were no significant differences between the effects of whole and ground Salba on glucose response.[20]

Exercise Performance

Chia was investigated as a method of carbohydrate-loading before sports performance lasting greater than 90 minutes in a small, nonblinded crossover trial involving six highly trained male subjects. The authors' primary intent was to determine if chia would allow athletes to reduce the amount of sugar ingested during traditional carbohydrate-loading, while increasing omega-3 fatty acid intake. The authors also hypothesized that chia's moderate carbohydrate and high fat content would be glycogen-sparing and assist in fat utilization during endurance exercise, thereby improving performance as measured by running time. However, fat utilization wasn't measured in this study; running time was the only measured outcome. Consumption of an omega-3 chia beverage (50% of kcal from Gatorade, 50% from Greens Plus Omega-3 brand chia seeds) was compared to that of an isocaloric control beverage (100% kcal from Gatorade). Authors didn't specify if chia seeds were whole or ground. The beverages were individualized to provide 6 g carbohydrates per kg body weight. Two days before testing, subjects completed an intense run followed by ad lib consumption of the chia beverage or Gatorade throughout the day.[17]

On the day of testing, subjects ran for one hour at 65% of their maximum oxygen consumption, measured by VO2 max, then completed a 10 km run on a track, the latter of which was timed. There was a two-week rest period between study phases, and the testing for each phase took place under similar weather conditions. Subjects kept food logs while in the first phase of the

study, and were instructed to eat in a similar manner during the second phase. The chia beverage didn't significantly affect running time but was found to be as effective as Gatorade alone in terms of its use as a performance-enhancing carbohydrate-loading method. The chia beverage didn't enhance performance beyond that of traditional carbohydrate-loading. Authors conclude carbohydrate-loading with chia seeds can increase athletes' omega-3 consumption and lower sugar intake without negatively affecting performance. In addition to an extremely small sample size, the limitations of this study include a lack of blinding; the subjects knew which beverage they were consuming.[17]

Skin: Itching, Scaling, and Related Conditions

In one study, five healthy subjects with xerotic pruritus (chronic itching and scaling skin) and five subjects with pruritus—itching—due to end-stage renal disease (ESRD) or diabetes, applied a lotion of 4% chia seed oil for eight weeks. The chia lotion was applied to one side of the body (left or right) and a placebo lotion without chia oil was simultaneously applied to the other side. Both subjective and objective assessments of the skin were used. After using the chia seed oil lotion, the subjects with ESRD or diabetes experienced significant improvements in skin dryness, lichen simplex chronicus (thickened, itchy skin), and prurigo nodularis (itchy nodules). The healthy subjects experienced nonsignificant improvements of all symptoms, yet still expressed a significant increase in degree of overall satisfaction.[22]

Plasma Lipids

In a follow-up to their 2009 study described above examining chia and weight loss, Jin and colleagues investigated the effect of ground chia seeds on plasma EPA, docosapentaenoic acid (DPA), and DHA. For seven weeks, 10 postmenopausal women consumed 25 g per day of milled chia while restricting omega-6 plant oils and marine sources of fatty acids, including fish, fish oil, and seafood. Subjects were permitted to consume olive and canola oils. There was no control group; subjects' measurements were compared with baseline. Plasma lipids were assessed at six time points throughout the study. After seven weeks, plasma ALA and EPA had significantly increased by 138% and 30%, respectively, whereas changes in DPA and DHA weren't significant. Of note, significantly higher ALA was achieved after just one week of chia consumption.[21]

Benefits of Boosting ALA

As discussed, research has shown chia to be effective in raising blood levels of ALA and EPA.[15,16,19,21] Altering these lipids in the blood is currently chia's most significant contribution to human health.

The Lyon Diet Heart Study's final report presents data from subjects followed for up to four years after an initial myocardial infarction. People consuming a Mediterranean diet high in ALA experienced lower rates of death, hospitalization, and cardiac arrest. Compared with the control group, the Mediterranean diet group had significantly higher blood levels of ALA and EPA; since fish intake wasn't different between groups, the authors state that higher EPA was likely due to the higher ALA ingestion of the Mediterranean diet group. Higher plasma ALA was also found to be inversely associated with fatal heart attack recurrence.[23] In addition, increased dietary ALA is associated with reduced risk of atherosclerosis, hypertension, and cardiovascular disease.[24-26]

Risks

To date, no adverse reactions have been reported regarding chia ingestion, and there are no known interactions with drugs, foods, herbs, or supplements.[1] However, there are a few potential risks to consider. Research has demonstrated ALA may elevate plasma triglycerides or worsen hypertriglyceridemia; supplementing with either 4.5 g or 9.5 g per day of ALA elevated fasting triglycerides significantly more than 1.7 g of combined EPA and DHA.[27] In contrast, Vuksan and colleagues didn't show an increase in triglycerides with a daily dose of 7 g ALA from 37 g (just less than 1/3 cup) of Salba brand chia seeds.[15]

Some evidence suggests high intakes of ALA may increase risk of (or worsen existing) prostate cancer, though the mechanism is unknown. Until more evidence is available, men diagnosed with (or at a high risk of) prostate cancer should avoid consuming large quantities of chia seeds and other ALA-rich foods such as flaxseeds.[28]

Clients with swallowing problems should never consume dry chia without first thoroughly soaking the seeds in liquid until completely plump. As chia expands upon contact with moisture, there's potential risk of obstruction if the seeds expand while within the esophagus without adequate liquid.[29]

Dosage and Culinary Usage

Chia has been used safely in doses of up to 50 g per day for up to 12 weeks.[16] Fifty grams of chia is equal to 0.42 cups, 2 T more than satisfies the adult DRI for ALA, and is an amount easily incorporated into everyday dining.

The culinary uses of chia seeds are only limited by the imagination. For clients who wish to incorporate chia into their diets, RDs can make the following suggestions:

• Soak chia seeds in water for approximately 10 minutes until plump; the soaked seeds have a gelatinous texture and blend well with moist foods such as yogurt, oatmeal, cereal with milk, fruit salad, and tomato sauce.

• Dry chia seeds can be directly added to any desired beverage and can be used to make a pudding; soak 1/2 cup dry chia seeds in 2 cups milk, add honey or maple syrup to taste, and let stand overnight.

• Baked goods can be improved with chia; up to 25% of oil or egg in cake recipes may be replaced with soaked chia seeds (chia gel) without affecting weight, volume, or taste of the final product.[30]

Putting It Into Practice

For now, the evidence isn't available to determine that chia is a weight loss panacea, can sustain athletes for hours at a time, or tame diabetes. Emerging evidence suggests chia may assist in prolonging satiety,[14] reducing blood pressure,[15] attenuating postprandial glycemia,[14,20] and improving certain symptoms associated with pruritus.[22] However, without a more complete

body of evidence, RDs can't recommend chia specifically for these purposes. More research is needed to clarify chia's potential ability to improve and sustain human health.
As a dense source of ALA, chia does indeed have a role to play in cardiovascular health. As discussed, the cardiovascular health benefits of a diet rich in ALA are well documented,[23-26,28] and chia is a delicious and versatile way to ensure ALA needs are met.

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Quiz

1. The predominant omega-3 fatty acid in chia is which of the following?
A. DHA
B. Linolenic Acid
C. EPA
D. Alpha-linolenic acid (ALA)

2. In the two studies discussed that investigated chia's effects on weight loss and body composition, what was the only statistically significant finding?
A. Chia reduced waist circumference.
B. Weight loss was greater in chia consumers.
C. Chia raised blood levels of ALA.
D. Body fat percentage decreased with chia consumption.

3. What causes chia seeds to form a gelatinous mucilage capsule when soaked in liquid?
A. Chia's high pectin content
B. Soluble fiber polysaccharide chains
C. Insoluble fiber lignins
D. Quercetin and kaempferol, chia's major antioxidants

4. Which of the following are among the limitations of current research on chia?
A. The studies are short-term with small sample sizes.
B. Only subjects with diabetes were examined.
C. The strong taste of chia cannot be concealed for blinded placebo-controlled trials.
D. Only pediatric subjects were examined.

5. For which condition would chia consumption be contraindicated?
A. Diabetes
B. Prostate cancer
C. Metabolic syndrome
D. Hypertension

6. In the study of subjects with type 2 diabetes, what was the effect of consuming 33 to 41 g of chia per day?
A. Had no effect on any outcome measures
B. Lowered triglycerides and postprandial glycemia
C. Increased satiety
D. Lowered systolic blood pressure

7. Higher plasma ALA has been linked to which of the following?
A. Lower risk of cardiovascular disease, atherosclerosis, and hypertension
B. Smaller waist circumference
C. Increased postprandial satiety
D. Weight loss

8. Consuming chia seeds before long distance running has been shown to improve performance time.
A. True
B. False

9. What is the easiest and safest way to eat chia?
A. Swallow the dry seeds by the spoonful.
B. Grind the seeds to sprinkle on foods.
C. Soak chia seeds in water until plump, and then stir into foods or beverages.
D. Toast and grind the seeds and soak the chia powder in water.

10. What serving of chia seeds would satisfy a 45-year-old woman's Dietary Reference Intake for ALA?
A. One tablespoon of dry seeds
B. One tablespoon of soaked seeds
C. One teaspoon of dry seeds
D. One teaspoon of soaked seeds