

Use of Different Vegetable Products to Increase Preschool-Aged Children's Preference for and Intake of a Target Vegetable: A Randomized Controlled Trial



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ABSTRACT

Background Children's low vegetable consumption requires effective strategies to enhance preference for and intake of vegetables.

Objective The study compared three preparation practices for a target vegetable (spinach) on their effectiveness in increasing preschool-aged children's preference for and intake of the target vegetable in comparison to a control vegetable (green beans).

Design We conducted a randomized controlled trial with four parallel groups: plain spinach, creamed spinach, spinach ravioli, and green beans. During the intervention, children were served the vegetable at their main meal six times over 6 weeks at home.

Participants/setting Children aged 2 to 4 years were recruited from six child-care centers located in Wageningen, the Netherlands, and randomly assigned to one of the four groups, with vegetable products provided by the researchers. The study was performed between September 2014 and January 2015. In total, 103 children participated, with 26, 25, 26, and 26 in the plain spinach, creamed spinach, spinach ravioli, and green beans groups, respectively.

Main outcome measures Preference for and ad libitum intake of cooked spinach were assessed during a test meal at the day-care center pre- and postintervention. Food neophobia was assessed via the Child Food Neophobia Scale.

Statistical analyses performed General linear model repeated measures analysis, including food neophobia, spinach liking, exposure, and consumption scores as covariates, was performed to test for effects of group on intake. Logistic regression was used to assess changes in preference between pre- and postintervention.

Results All four groups significantly increased their spinach intake from pre- (53 g) to postintervention (91 g) by an average of 70%. For preference, no significant shift toward the target vegetable was found from pre- to postintervention. The effect on intake depended on the child's neophobia status and preintervention spinach consumption, with children with neophobia being less responsive to the intervention and with children who ate more spinach before the intervention being more responsive to the intervention.

Conclusions These findings suggest that repeated exposure to differently prepared spinach products, or even another green vegetable, improved children's spinach intake. However, children with neophobia may need a different approach.

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YOUNG CHILDREN'S VEGETABLE CONSUMPTION IS far below what is recommended.¹⁻⁴ Getting children to eat sufficient vegetables is a universal concern. Parents want their children to have a varied diet, of which vegetables are viewed as an essential part. However, it remains a challenge to achieve sufficient intake of a variety of vegetables, because children often initially dislike vegetables because of their appearance and bitterness.^{5,6} Different preparation techniques like blending, mixing, mashing, puréeing, or seasoning are used in practice to improve children's vegetable intake.^{7,8} In many of these techniques,

vegetables are (covertly) incorporated in, or mixed with, other foods to dilute somewhat or mask the pure, often disliked, vegetable taste and texture. This could enhance children's vegetable preference and intake.

It has been proposed that covertly incorporating vegetables into other foods increases vegetable intake, but to our best knowledge, this has not been demonstrated experimentally. One study investigating dietary habits in early infancy with a focus on vegetables interviewed and questioned mothers about daily practices in the United Kingdom, and the responses indicated that several techniques, such as modeling,

modifying the taste or texture, masking the taste, or presenting the vegetable in a processed form, were popular methods to stimulate children's vegetable intake. One popular technique involved so-called vegetables by stealth, where vegetables are incorporated or hidden in a dish or meal component (eg, soup and pasta sauce) that makes them less identifiable as vegetables.⁸ Another study investigated whether incorporating puréed vegetables into entrées and, thereby, reducing the energy density, led to increased vegetable intake. It was shown that preschool children ate more vegetables when bigger portion sizes were incorporated in dishes served as entrées.⁹ The question remains whether preference for a vegetable is influenced by consuming products that mask its taste and texture. It has been proposed that to increase preference, children should learn to recognize the taste and texture of a food in its pure form.^{10,11} Hence, the topic of this study is not solely about the effect of repeatedly serving a target vegetable on intake, but to investigate whether different preparation techniques of the target vegetable, resulting in different vegetable products, differentially contribute to the positive effects of repeatedly serving the target vegetable on preference and intake.

Apart from a dislike of vegetables because of their characteristic sensory properties (ie, taste, texture, and mouth-feel), food neophobia (ie, the fear of trying/testing a novel food) is strongest for vegetables among all food product categories in 2- to 6-year-old children.^{12,13} It remains unclear what strategy, if any, is most effective in increasing vegetable preference and intake, during this challenging age period when neophobia peaks.^{14,15}

The aim of the current study was to investigate the efficacy of offering vegetables prepared in different ways to improve preference for and intake of the vegetable in preschool-aged children. The target vegetable, spinach, was prepared in three ways; cooked in its pure form, diluted with cream, and hidden as filling for ravioli. The second objective was to investigate how food neophobia mediates the efficacy of using different vegetable products to enhance vegetable preference and intake.

METHODS

Participants

One hundred four children aged 2 to 4 years were recruited (June to August 2014) from six day-care centers in Wageningen, a small city in the middle of The Netherlands. Participation was voluntary. The study was conducted (between September 2014 and January 2015) according to the guidelines laid down in the Declaration of Helsinki, and all procedures were approved by the Institutional Review Board of Wageningen University and registered at Dutch Trial Registration (no. NTR4755). Written informed consent was obtained from the participating children's parents. Parents and day-care center employees were thoroughly informed about the study by an information booklet and information session before the intervention. Participants were screened for food allergies and health problems (as reported by the parents); this resulted in 103 participants. Sample size calculation was based on the standard deviation (SD) of the mean vegetable consumption of Dutch children aged 2 to 4 years (ie, 34 g), and an expected increase set at half an SD (17 g; 1 T cooked vegetables).⁴ To detect a significant

difference between the groups, with alpha set at .05 and a power of 0.80, at least 25 children were needed per group. Participants could withdraw from the study at any time for any reason without any consequences.

Study Design

A between-subjects design (parallel groups) was used to identify potential group differences in plain cooked spinach intake before and after the intervention. Groups differed from one another on how the target vegetable was prepared during the intervention. Children were randomly assigned to one of the four groups using a four-block design: green beans (control), plain spinach (pure spinach), creamed spinach (diluted), and spinach ravioli (hidden). Randomization was done by a person who was not involved in study recruitment, enrollment, or assignment of participants. Pre- and post-intervention measurements were taken of ad libitum intake of plain cooked spinach and preference for spinach compared with green beans (see Study Products), 1 week before and 1 week after the intervention at the day-care centers. During the intervention, children were served their assigned vegetable product once per week at home at the main meal in the evening, for 6 weeks in total. Depending on the assigned group, children and their families received only one of the four vegetable products (ie, green beans, plain spinach, creamed spinach, or spinach ravioli) during the intervention. [Figure 1](#) provides a schematic timeline of the study.

Study Products

Spinach was chosen as the target vegetable because it is a green leafy vegetable and generally not liked by children.^{6,16} Green beans were chosen as a control vegetable because children generally like this vegetable better, and it is among the most-consumed vegetables.⁴ Both vegetables fit into a typical Dutch main meal of potatoes/rice/pasta, vegetables, and meat/fish/vegetarian product. The target vegetable was offered in three products. Plain cooked spinach; creamed spinach was plain spinach diluted with some cream to lessen the stringent spinach taste; and ravioli spinach was plain spinach covered in an envelope of pasta, so that the child was less aware of consuming spinach. Green beans were offered as a different green vegetable; that is, control. The products in the plain spinach, creamed spinach, and green beans groups were commercially available (frozen green beans [2.5 kg], frozen chopped spinach [2.5 kg], and frozen spinach a la crème [1 kg]) and were repacked in family portions and delivered frozen via the day-care centers on a weekly basis. The packages contained the Recommended Dietary Allowance (RDA) of vegetables for the whole family, to ensure that every member of the family could comply with the RDA. The spinach ravioli product was developed especially for this study after consultation with an Italian caterer. Each individual ravioli contained 70% spinach (ie, approximately 18 g frozen chopped spinach, as used in the plain spinach group) in the total weight. To meet the RDA, and to serve an equal amount of spinach as in the plain spinach and creamed spinach group, three pieces of ravioli were served to the child per meal.

The spinach used for the ad libitum intake during the pre- and posttests at the day-care centers was plain cooked spinach (98% frozen chopped spinach). Small amounts of

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