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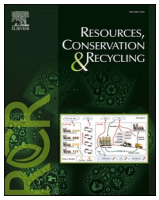

Full length article

Investigating goal conflicts in menu planning in Swedish school catering on the pathway to sustainable development

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ABSTRACT

The 260 million publicly funded school meals served annually in Sweden generate 21.000 tons of food waste. At national level, school meals should meet the goal of food waste reduction, together with various other goals such as meeting nutritional requirements, being environmentally friendly and, most importantly, achieving high acceptance among schoolchildren. There is a preconception among kitchen staff that the most popular school meals drive food waste in Swedish school catering and that vegetarian dishes increase food waste, despite being less popular than meat options. By applying mixed methods, this study investigated possible goal conflicts between reduced food waste, high acceptance, and vegetarian options on the lunch menu. An overall aim was to gain knowledge on how lunch menus could be adapted for increased sustainability. Kitchen staff from 10 Swedish primary and secondary schools were interviewed to identify the most popular and unpopular meals, and food waste quantification data and lunch menus from 61 school canteens were analyzed. The results showed that, while the common perception of popular and vegetarian meals creating most waste was held by kitchen staff, it proved to be untrue. In fact, popular school meals and vegetarian options generated less waste than unpopular meals. A vegetarian paradox was detected in interviews, with vegetarian options considered unpopular but with several vegetarian options among the most popular dishes. Thus, school-catering units should stop serving unpopular meals and shift their focus to serving popular nutritious meals, including popular plant-based options, as part of efforts to make school meal schemes more sustainable.

1. Introduction

Food waste is a global issue that comes at an enormous environmental, social, and economic cost of 2.6 trillion USD per year (FAO, 2014). To tackle the food waste issue, the United Nations Agenda for Sustainable Development has set a global target to halve food waste per capita at retail and consumer level by 2030 (United Nations, 2015). To contribute to this global target, Sweden has implemented an action plan to reduce food loss and waste by 2030 (Swedish Food Agency et al., 2018). Large amounts of food are wasted in Sweden, as excess food intake (i.e., metabolic food waste), amounting to 0.5 million tons per year, and as direct waste, estimated at 1.1 million tons per year (Hultén et al., 2022; Sundin et al., 2021). In 2020, an estimated 33,000 tons of food waste were disposed by large-scale catering establishments in Sweden (Hultén et al., 2022). The actual amount of food waste varies between school kitchens and between different areas in Sweden, but in 2020 the national average for total food waste from school kitchens was approximately 50 gs per pupil, excluding beverages (Malefors et al., 2022a). Since food waste is generated throughout the entire food supply chain, reduction efforts are necessary at each step, including public catering establishments in schools and preschools, to reach the overall reduction target by 2030.

School meals in various forms are served around the world, but the Swedish school meal scheme is considered unique due to its inclusiveness. A midday meal is served free of charge every weekday to all pupils of compulsory school age (6–15 years) and to most students in upper secondary school, regardless of parental income (Swedish Parliament, 2010). Thus every year, 260 million publicly funded school meals are served in Sweden (Swedish Food Agency, 2022a). The overall responsibility for these meals lies with municipalities, and the practicalities of planning and cooking, and kitchen facilities, may differ across Sweden. However, in all cases the meals are served hot, usually with

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several alternatives to choose from, and are accompanied by salad, bread, spread, and milk or water. Since 2011, Swedish law stipulates that school meals must be nutritious (Swedish Parliament, 2010), and according to national guidelines they must supply one-third of recommended daily energy and nutrient intake in children (Swedish Food Agency, 2021). The national guidelines state the importance of pupils enjoying school meals, while at the same time challenging their taste preferences. School meals are also intended to be a teaching occasion (educational meals), where children can learn healthy eating habits and are encouraged trying new foods (Persson Osowski and Fjellström, 2019). Exposing children to food may increase their liking of different foodstuffs (Birch and Fisher, 1996; Cooke, 2007), whereas forcing them to eat may result in food rejection (Batsell et al., 2002). Learning healthy eating habits is essential, for example, in preventing overweight and obesity in children, the prevalence of which is high and increasing with age in Sweden (Public Health Agency of Sweden, 2019). Thus, the school meal scheme serves an important function in promoting public health in Sweden contributing to a more equal society and sustainable development.

In addition to meeting nutritional requirements through school meals, there is an increasing focus on environmental sustainability, through reduced food waste and also by making conscious choices, such as cooking more plant-based meals to reduce the carbon footprint. Already, 70% of Swedish municipalities have set targets to reduce food waste, while more than 33% have taken their own initiative in setting reduction targets for the climate impact of food consumption (Swedish Food Agency, 2022b). Offering a daily vegetarian alternative is not mandatory in Swedish school catering but has become increasingly common, with 63% of municipalities offering vegetarian alternatives to their pupils in all primary and secondary schools, in accordance with the national guidelines (Swedish Food Agency, 2022b). However, in order for school meals to fulfill their fundamental purpose in terms of promoting public health while being environmentally sustainable, the meals must achieve high acceptance among schoolchildren. Food that is not eaten, no matter how nutritious or environmentally conscious, serves no purpose.

Meeting all these goals simultaneously could be challenging. In fact, there is a common perception among kitchen staff in Sweden that the most popular school meals generate the most food waste, suggesting a potential conflict between high acceptance and environmental sustainability of school meals (Eriksson et al., 2016; Prim and Broberg, 2013). Consequently, kitchen staff may limit the quantity of food that pupils can be served in a single serving, in order to reduce food waste. These types of actions are unpopular among pupils, who interpret them as an attempt to limit how much they are allowed to eat (Bjernevall, 2022).

It is not clear whether the common perception that popular school meals generate most waste is true, but it is treated as fact since catering staff use it as justification to reduce the portion size of popular dishes. It may have arisen from the notion of greater wastage of popular meals due to schoolchildren taking larger portion sizes of these meals. Larger portion sizes have been identified as a factor significantly increasing plate waste in school and work canteens (Boschini et al., 2020; Lorenz-Walther et al., 2019; Pires et al., 2022; Steen et al., 2018). When popular school meals are served, pupils prefer to opt for larger portions instead of awaiting second servings, to avoid unnecessary queuing time and due to a fear that the food will run out (Eriksson et al., 2016). Pupils also seem to think that they can eat more of their favorite dishes, although in reality they cannot always finish the whole portion (Eriksson et al., 2016; Modin, 2011). However, not liking the food is reported to be another main reason for pupils wasting served school meals (Boschini et al., 2020; Cordingley et al., 2011; Prim and Broberg, 2013). Unpopular school meals have also been associated with more serving waste with food being prepared, but not served (Cordingley et al., 2011).

To assess the wastage levels of the most popular and unpopular school meals, the preferences of schoolchildren need to be known. According to previous studies conducted in Sweden, the most popular meals include pancakes, hamburgers, tacos, pizza, chicken, pasta Bolognese, and lasagna (Eriksson et al., 2016; Prim and Broberg, 2013). The most unpopular meals are reported to be fish with potatoes, black pudding, potato pancakes, and beef with potatoes (Eriksson et al., 2016). However, evidence is lacking regarding the most popular and unpopular vegetarian school meals in Sweden and the degree to which these are wasted. Unpopularity of vegetarian school meals in general, including components such as salad and fruit, has been highlighted by some previous studies, suggesting that these meals contribute to increased food waste levels (Byker et al., 2014; Byker Shanks et al., 2017; Donadini et al., 2022; Smith and Cunningham-Sabo, 2014). In addition, plant-based protein sources have been shown to lead to increased plate waste in schools (Lindke et al., 2022). On the other hand, increased acceptance of vegetarian dishes among schoolchildren has also been indicated (Keyzer et al., 2012; Lazor et al., 2010; Lombardini and Lankoski, 2013).

Several previous studies have investigated food waste levels in school catering (Eriksson et al., 2017, 2019; Malefors et al., 2019, 2022b; Östergren and Backlund, 2019). However, large-scale studies investigating possible goal conflicts between high meal acceptance, reduced food waste, and vegetarian options are still scarce. Accurate knowledge on how to develop school lunch menus that provide meals with high acceptance among pupils, while maintaining high sustainability through low levels of food wastage and reduced meat consumption, is essential for transition to a more sustainable food system. Therefore, the aim of the present study was to investigate whether high or low acceptance and the presence of vegetarian meals on the school lunch menu influence food waste levels. A further aim was to gain an in-depth understanding of kitchen staff's perspectives on the wastage associated with school meals and on how the school lunch menu could be adapted to reduce the environmental impact.

2. Material and methods

Mixed methods combining qualitative and quantitative approaches were applied to enable a more complete and comprehensive analysis of the wastage of school meals in relation to their popularity. First, qualitative data from semi-structured interviews (Kvale, 1996) with kitchen staff were used to categorize the level of popularity (level of acceptance) of different meals among schoolchildren. The interviews also aimed to explore kitchen staff's perspectives and experiences regarding food wastage in school catering. These qualitative data were then combined with quantitative food waste data on lunch menus in school canteens. The study design is illustrated in Fig. 1.

2.1. Qualitative method

The interviews were conducted using a semi-structured interview guide. In semi-structured interviews, participants can speak freely about issues that are important to them, allowing for a variety of perspectives to be conveyed, while the interview adheres to the topic through preformulated questions (Kallio et al., 2016). To test the interview guide and allow revision of the interview questions, four pilot interviews were conducted with kitchen staff from two primary schools and one preschool in Stockholm. In these pilot interviews, the kitchen staff were asked partially open-ended semi-structured questions. The interview questions were slightly reformulated based on the results, but without any major changes to the content, resulting in 12 interview questions (see Appendix A).

After completing the pilot interviews, actual data collection was conducted by interviewing school kitchen staff in Uppsala Municipality in March 2022. To recruit participants, the convenience sampling method was used. Those responsible for school meals in the municipality were contacted, and in turn provided a list of suitable contacts among the kitchen staff. In total, 13 kitchen staff members from seven primary and secondary schools participated in face-to-face interviews. The

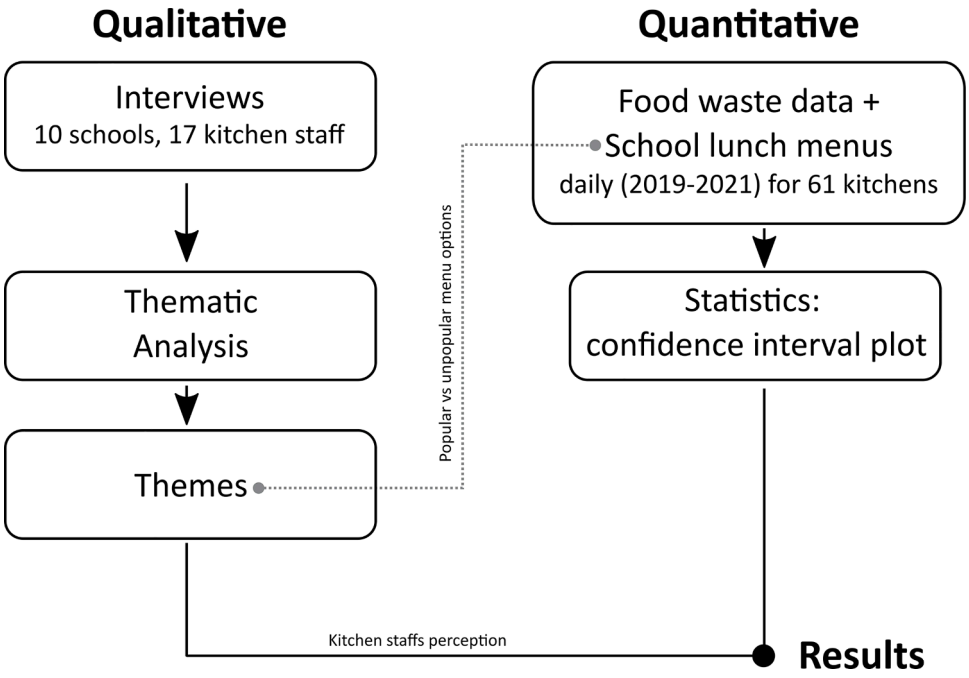

Fig. 1. Study design applied, including qualitative and quantitative methods and procedures used to collect and analyze data.

interviews were conducted in either Swedish or English by two research team members, with each interview lasting approximately 20 min. Questions were asked about (1) popular and unpopular dishes; (2) popular and unpopular vegetarian dishes; (3) pupils' attitudes to school meals; (4) the kitchen's strategies to lower food waste; and (5) the impact of these strategies on the pupils. During the interviews, notes were made using a laptop computer, with pauses to type in the answers when necessary. As both the questions and responses were similar for the pilot and actual interviews, the pilot interview results were included in the final analysis. Thus in total, 17 kitchen staff from one preschool, seven primary schools, and two upper secondary schools in Sweden were represented in the data. Informed written consent was obtained from each participant and the participants were allowed to withdraw their consent at any time. All data were treated confidentially, and the participants were coded to protect their anonymity (Appendix B). During the study, no sensitive personal data were collected from the interview participants and therefore obtaining ethical approval was not necessary.

2.2. Quantitative methods

All food waste quantification data were collected at canteen level by kitchen staff themselves as part of their daily routine. They weighed all food waste generated during lunches according to the standard established by the Swedish Food Agency, (2020), whereby food waste is divided into *kitchen waste* (waste produced in production kitchens), *serving waste* (leftovers from servings that never reach guests' plates), and *plate waste* (guests' unconsumed waste). Because kitchen waste represents a relatively small fraction (8%) of the total food waste generated in Swedish school kitchens, only serving waste (48%) and plate waste (44%) were included (Malefors et al., 2019). Each guest who attends the meals is also counted as part of the food waste quantification work, to calculate the relative indicator 'waste per guest' (in grams). The quantification work took place in 61 school canteens in Uppsala Municipality and the data collected covered the period November 2019 to September 2021. In addition to serving waste and plate waste quantification data, lunch menu data for the same period as the food waste data were obtained from the municipality and used in the analysis.

All data were subjected to a cleaning process in which any doubtful data, such as food waste recorded in grams instead of kilograms, were corrected. The next step was to establish a basis for analyzing the canteens on equal terms, i.e., only data from canteens that quantified the amount of serving waste, plate waste, and guests per day were selected for further evaluation. If a canteen did not quantify one of these parameters on a particular day, all data for that day were discarded, as further explained by Malefors et al. (2019). To enable robust analysis of the key performance indicator 'waste per guest' (g), the median value was used to reduce the impact of outliers or extreme values. Data on the lunch menus, which were served buffet-style and consisted of 1–3 main hot meals per day, mostly with at least one vegetarian option, were combined with the food waste data on a daily basis.

2.3. Analysis

The qualitative data were interpreted using thematic analysis (Braun and Clarke, 2006). The interview transcripts were first translated into English and the translations were then double-checked to ensure their accuracy. The analysis started with reading the data, with the researchers reading the transcripts several times to determine the appropriate codes. The codes were grouped into sub-themes, which were then merged into broad themes. In the coding process, codes and themes were discussed repeatedly to ensure that all researchers shared the same interpretation.

The interview data were also used to categorize the menus. Since the school meals were served buffet-style, food waste quantification data on meal or food item level were not available. Therefore based on kitchen staff's statements in the interviews, the daily lunch menus were categorized into three types: 'high acceptance', 'low acceptance', and days with 'both' high acceptance and low acceptance meal options. The category 'high acceptance' comprised days when only popular options were served, while 'low acceptance' comprised days when only unpopular options were served. Hereafter, the terms high/low acceptance and popular/unpopular are used interchangeably. Furthermore, based on what was served, the menus were classified as days with a 'mixed menu', i.e., with both vegetarian and non-vegetarian meals being served, and days with a 'vegetarian menu', i.e., with solely vegetarian meals being served. The results on the popularity of meals and vegetarian meals were then used as categorization input for the quantitative

analysis. The quantitative material used for analysis was based on 9262 observations from 61 kitchens, as summarized in Table 1.

The results are presented as grouped scatter plots with confidence intervals (95% level) comparing food waste quantities between days when popular meals, unpopular meals, or both popular and unpopular meals were served. The food waste plots are further divided into mixed menu and vegetarian menu days. The qualitative and quantitative data were combined in the final analysis.

3. Results

The analysis resulted in three themes: 1) the vegetarian paradox; 2) the waste myth concerning popular school meals; and 3) methods for mitigating food waste. These themes are presented below, with exemplifying quotes and supporting quantitative data when applicable.

3.1. The vegetarian paradox

The opinions about popular and unpopular meal options were similar among kitchen staff at the various schools. According to the kitchen staff, unpopular meal options included vegetarian dishes in general, as well as stews, fish stew, fish gratin, and meals including visible vegetables and mixed ingredients:

> "Strange vegetarian dishes, lentils, vegetables, they [pupils] are afraid of these. Some fish gratin, they [pupils] don't like it." (001)

Meatballs, pasta, spaghetti bolognese, various potato dishes, chicken, hamburgers, lasagna, sausages, and tacos were considered the most popular meal options, but also pancakes, which were vegetarian:

> "Most popular are pancakes, the only dish they don't regard as vegetarian." (001)

Thus, a vegetarian paradox was detected in the material, with kitchen staff claiming that all vegetarian dishes are unpopular but with several vegetarian meal options among the most popular dishes. The most popular vegetarian meal options were pancakes, vegetarian nuggets, vegetarian schnitzel, red lasagna, potato pancakes, vegetarian tacos, and vegetarian soups. Other meal options considered popular, but not mentioned as many times, were falafel, soy sausage, curry with Quorn, and pasta with gorgonzola. Unpopular vegetarian options were vegetarian patties with rice, beans, peas, mixed stews or stews with legumes, lentils, dishes where the vegetables were visible, cabbage pudding, and mushrooms. Some vegetarian dishes, such as vegetarian patties, vegetarian nuggets, stews, soy sausage, and gratin with cheese, divided opinion, as they were considered both popular and unpopular.

Some kitchen staff mentioned unfamiliarity with vegetarian dishes as the reason for pupils disliking these dishes. The kitchen staff also explained that the popular vegetarian dishes, such as pancakes and potato pancakes, were not considered vegetarian, because they did not include any visible vegetables. The kitchen staff reported that the pupils accepted vegetables when served as tacos, nuggets, or lasagna, i.e., in cases where the dishes looked or tasted similar to meat.

> "They like soy sausage, they like vegetarian tacos. They like when it tastes or looks like meat." (008)

Table 1
Numbers of days with menus classified as 'high acceptance meals', 'low acceptance meals' and 'both' high acceptance and low acceptance meals, further divided into days with a mix of vegetarian and non-vegetarian options ("Mixed menu") and days with only vegetarian options ("Vegetarian menu").

	Mixed menu (n)	Vegetarian menu (n)
High acceptance meals	1209	536
Low acceptance meals	1629	488
Both	4018	1382
Total	6856	2406

The kitchen staff also reported that the pupils wanted varied school lunches, especially the salad buffet offering side dishes. These vegetarian meal options were considered popular and included potato salad, pasta salad, "pizza salad" (cabbage mixed with oil, vinegar, pickled peppers and seasoning), and raw vegetables, such as tomato, cucumber, and sweet pepper served in separate serving bowls. However, serving these was not always possible for budget reasons. During winter in particular, it was challenging to offer as large a variety as pupils would like in the salad buffet for cost reasons, according to the kitchen staff.

3.2. The waste myth concerning popular school meals

The interviews revealed that the perception that the most popular school meals generate most waste was commonly held by the kitchen staff. As an explanation, the staff highlighted pupils' behavior of taking too large portions of their favorite food, but then not being able to clear their plates. As a result, more plate waste was generated, in their opinion:

> "The popular dishes are thrown away the most. The least favorite dishes are not wasted as much. Some pupils think they like the food and therefore take more, but it can be wasted because they can't finish it or because they think the taste is not good enough." (001)

This perception that popular dishes result in more waste appears to be a myth. In fact, the quantitative results indicated a lower level of food waste for popular compared with unpopular lunch menus, as illustrated in Fig. 2. On analyzing *serving waste* and *plate waste* combined with lunch menu data, in most cases it was found that unpopular dishes generated more food waste than popular dishes, regardless of whether the menu of the day was mixed or vegetarian. More specifically, days when unpopular dishes were served had significantly higher levels of *plate waste* than days when popular dishes were served. The amount of *serving waste* was also significantly higher on days with unpopular options than on days with popular options when a mixed menu was served.

In the case of mixed menus, popular meals generated 11% less *plate waste* than unpopular meals. In the case of vegetarian menus, analysis of *plate waste* revealed that the amount was 19% higher when unpopular meals were served in comparison with popular meals. In terms of serving waste, on days with a mixed menu, unpopular meals generated 21% more *serving waste* than popular meals. On days with a vegetarian menu, there was no difference in *serving waste* between unpopular and popular meals.

On days with mixed menus, the sum of plate waste and serving waste was 49.5 g/guest when unpopular meals were served, and 41.2 g/guest when popular meals were served indicating a reduction of 17% in food waste. However, on days with a combination of unpopular and popular meals, food waste totaled 44 g/guest, which also indicated a reduction (−11%), on days with a mixed menu. On days with a vegetarian menu, a food waste reduction of 21% was found between days with unpopular meals (49.6 g/guest) and days with both unpopular and popular meals (39.2 g/guest) when plate waste and serving waste were summed up.

3.3. Methods for mitigating food waste

The staff used various methods for mitigating food waste. With some exceptions during the Covid-19, the pupils were serving themselves the amount of food they wished to have, however, the staff tried to encourage pupils to consider their portion sizes by encouraging them to take smaller portions first and come back for seconds later. One school also had a separate line for second servings to reduce queuing time, thereby minimizing the risk of children serving themselves too much on the first occasion, as they know that they would have time to come back for seconds. Another method used for mitigating waste was to use the leftovers as ingredients for other meals on the following day. A third strategy was to change the amount of food prepared, with some kitchens reducing the amount of food they prepared on days when unpopular

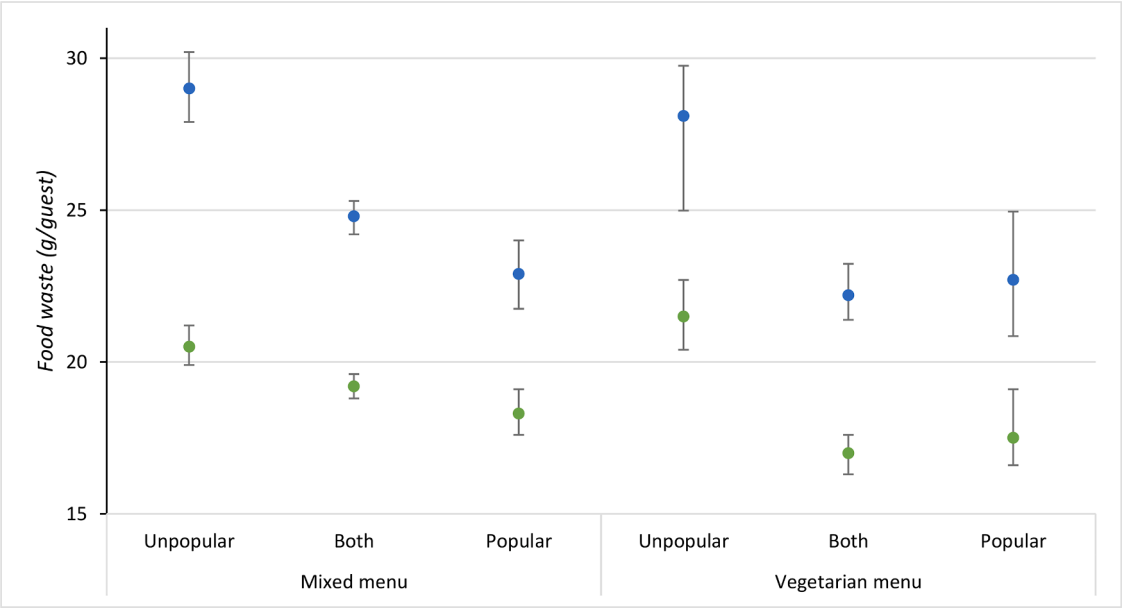

Fig. 2. Food waste levels, divided into serving waste (●) and plate waste (●), of popular and unpopular dishes served in a mixed menu and a vegetarian menu.

dishes were served. To ensure that the pupils had enough food to eat on those days, kitchen staff increased the amount of side dishes, such as baked bread. This strategy was followed because the pupils tended to eat more of the side dishes, instead of the main courses, when unpopular meal options were on the menu:

> "When they [pupils] do not like the food, they eat the side dishes or pasta/rice/potato instead." (011)

To overcome the problem of unpopular visible vegetables, the kitchen staff reported that they simply concealed the vegetables in the dishes, thereby increasing the popularity of such meals:

> "If you can hide the vegetables, they [pupils] eat them; the kitchen tries to hide the vegetables." (001)

Perceptions among the kitchen staff about the level of wastage associated with vegetarian dishes varied, with some stating that vegetarian dishes generated more waste than non-vegetarian dishes and others claiming the opposite or reporting no difference. To increase pupils' intake of vegetarian dishes, one kitchen had used a nudging strategy by changing the order of the lunch buffet to place vegetarian dishes first (Bucher et al., 2016). This move was considered rather effective in increasing pupils' intake of vegetarian dishes, although staff reported that the pupils still preferred non-vegetarian dishes.

Some of the kitchen staff interviewed reported that their methods for lowering food waste had actually worked, while others reported the opposite. A common challenge mentioned during the interviews was difficulty in increasing pupils' interest in reducing food waste on their own, and kitchen staff felt that they needed support from the teaching staff in this regard. According to the kitchen staff, younger pupils usually listened to them more closely, while the older pupils mostly did not take their advice seriously:

> "The younger children listen more and understand more about food waste, especially when you talk to them. The younger pupils also have more teachers eating with them and explaining food waste to them. But the older pupils barely notice or dont care about food waste." (003)

4. Discussion

This study investigated possible goal conflicts between high acceptance of school meals, reduced food waste, and including vegetarian options in Swedish school lunch menus. The results suggested that these goals are not conflicting and that there is scope for serving meals that fulfill all three goals. In fact, the results showed that unpopular lunch menus generated more food waste than popular menus, suggesting that *popular meals* should be favored over *unpopular meals* on school lunch menus. The results also indicated that vegetarian menus did not generate more food waste than mixed menus including meat, and in fact generated less in some cases, suggesting that *popular vegetarian meals* should be encouraged on Swedish school lunch menus. These findings contradict the common perception of popular meals generating the most food waste, which interviews revealed to be widely held among kitchen staff. The perception seemed to be rooted in a common view of pupils taking excessively large portions of the options they liked the most and not being able to finish these portions, resulting in more food waste. While previous studies have identified large portion size as a risk factor for plate waste (Steen et al., 2018), the results obtained in the present study suggest that the common perception that meals with high pupil acceptance generate the most food waste is erroneous.

Our analysis showed that unpopular menus generated more *plate waste* than popular menus, regardless of whether the lunch menu was vegetarian (+23%) or mixed (+12%). This is in line with findings by Thorsen et al. (2015) that *liking* school meals is negatively associated with percentage plate waste among Danish schoolchildren. Moreover, according to a recent survey of 15-year-old pupils in Sweden, success factors for reduced food waste in their opinion are *good food* and *tastiness* (Köhn and Boode Nylander, 2020). The results obtained in the present study contradicted previous findings of greater wastage of vegetarian meals and components (Byker et al., 2014; Byker Shanks et al., 2017; Keyzer et al., 2012; Smith and Cunningham-Sabo, 2014). On days when the lunch menu included meals of high and low acceptance, we found that the amount of plate waste was 13% lower and serving waste was 12% lower on vegetarian days than on days when the menu included meat options (mixed menu) (Fig. 2). We also found that popular vegetarian menus had a similar degree of plate waste as popular mixed menus, but 17% less plate waste than disliked mixed options.

Vegetarian options in general and dishes with visible vegetables were considered by kitchen staff to be low acceptance options among pupils. However, when more specific questions were asked, the interview responses paradoxically revealed that many vegetarian options, such as vegetarian nuggets, vegetarian schnitzel, red lasagna, potato

pancakes, tacos, and soups, actually had rather high acceptance among pupils, whereas meals containing legumes, lentils, beans, and mushrooms had low acceptance. This difference between liked and disliked dishes and food components could be partly caused by the food texture preferences of children, which have been found to be a major reason for them rejecting or accepting food (Cappellotto and Olsen, 2021). Interestingly, children living in northern European countries, such as Sweden, have been identified as *hard-likers*, while children living in southern Europe have been identified as *soft-likers* (Laureati et al., 2020). According to Laureati et al. (2020), *hard-likers* have lower consumption of legumes (commonly eaten soft-cooked), but higher consumption of vegetables (often served raw in the north), which could also explain our findings of high popularity of breaded foods (crispy, hard surface) and tacos, and the unpopularity of cooked vegetables, beans, and mushrooms (soft). However, we identified some contradictions in acceptance of certain vegetarian meals, as some options, such as vegetarian patties and nuggets and soy sausages, were considered both liked and disliked. The wider confidence intervals found for vegetarian menus in comparison with mixed menus (Fig. 2) could be due to this contradiction in acceptance of vegetarian meals, supporting the view that some pupils may like vegetarian options while others dislike them. A previous study identified significant differences in school meal liking, including vegetarian meals, based on pupils' sex (Donadini et al., 2022). Interviews with kitchen staff in the present study revealed that pupils' unfamiliarity with vegetarian meals and their perception of vegetarian food as consisting only of vegetables could partly explain the contradictory findings on acceptance of vegetarian options.

In the *vegetarian paradox* revealed by the interview material, several vegetarian meals were reported to be popular. The results also revealed a decreasing trend of food wastage when serving popular school menus instead of unpopular school menus, whether with vegetarian or mixed menus (Fig. 2). While the results demonstrated that serving unpopular school meals leads to a greater amount of food waste, it can also be concluded that serving popular meals is likely to lead to higher food intake among pupils in comparison with unpopular meals. Increasing the frequency of popular vegetarian options on school lunch menus could bring several advantages in addition to reduced food waste, e.g., it would reduce the carbon footprint of school meals and likely lead to more healthy and nutritious school meals. Diets low in greenhouse gas emissions have been found to be as nutritious as diets high in emissions (Bälter et al., 2017). Vegetarian eating patterns may also be associated with a reduced risk of negative health outcomes, including diabetes, ischemic heart disease, and cancer risk (Oussalah et al., 2020). The prevalence of overweight and obesity among children is high and on the rise, so prevention measures are of the utmost importance (Public Health Agency of Sweden, 2019). Overweight and obesity are major contributors to ill health, and are also an environmental burden contributing to metabolic food waste (Sundin et al., 2021; WHO, 2021). The causes of overweight and obesity are complex, but the fundamental cause is considered an energy imbalance between energy intake and expenditure, often caused by so-called obesogenic environments where energy-dense foods are readily available and sedentary lifestyles prevail (WHO, 2021). While high acceptance, or high intake, of school meals could be argued to contribute to overweight, and thus metabolic food waste, school meal schemes have been identified as a key measure in prevention of childhood obesity, through their ability to promote healthy food environments for children (European Commission, 2013). Serving nutritious and increasingly plant-based school meals that are popular among pupils is likely to play an important role in this regard.

Our interviews with kitchen staff uncovered some successful strategies that they use to increase pupils' liking for unpopular vegetarian meals, in an attempt to reduce food waste. One strategy was to hide vegetables in different dishes. Another strategy was to cook vegetarian meals that look and taste similar to popular meat options, such as tacos, nuggets, or lasagna. Since kitchen staff are first-hand observers of pupils' meal acceptance, close co-operation between municipal menu planners and kitchen staff, exploiting the experience and cooking skills of the kitchen staff, could be an important factor for success in developing school lunch menus that meet different economic, environmental, and nutritional goals. However, meeting multiple goals can be challenging, with kitchen staff indicating that they would need help from teaching staff to reduce waste. In particular, the staff regarded older pupils as hard to reach and as generating more food waste, which is in line with previous findings (Eriksson et al., 2017; Steen et al., 2018). Educational meals, where school lunches are integrated with appropriate teaching activities in order to promote healthy eating habits for children (Persson Osowski et al., 2013), are a possible solution warranting further study.

The kitchen staff interviewed in this study applied some food waste mitigation measures with potential implications for the nutrient intake of schoolchildren. Some kitchen staff asked pupils to start with one portion and come back for a second serving, especially when popular meals were served. The intention of the kitchen staff was not to limit food intake by the pupils, but rather to prevent plate waste, but there is a risk that this measure could be misinterpreted by the pupils as a way to restrict their intake (Bjernevall, 2022). Therefore, communications on portion limitations must be very clear, to avoid such misunderstandings and ensure the satiety of schoolchildren. Another food waste mitigation measure was to cook less food and serve more bread and side dishes instead, to ensure satiety of the schoolchildren on days when unpopular meals were on the lunch menu. However, school meals are usually carefully planned, including calculations to ensure that the nutritional requirements of schoolchildren are met (Swedish Food Agency, 2021), and similarly to plate waste, deviating from the plan could have implications for nutrition intake among pupils. This type of measure can be considered as sub-optimizing the goal of school meals, whereas simply replacing unpopular meals with popular meals would likely lead to a more optimal solution.

There were some weaknesses with the present study, e.g., qualitative data on popular and unpopular school meals were obtained from kitchen staff instead of pupils. However interviewing the kitchen staff was also a strength of the study, because of their knowledge and experience regarding food wastage, food service, meal preparation, and school meal acceptance. The categorization of popular and unpopular dishes was based on interviews from only two municipalities in Sweden, which is a possible weakness. However, 17 kitchen staff were interviewed in total and the popularity of dishes was consistent among the interviewees and agreed with previous literature (e.g. Eriksson et al., 2016), so the results are likely to be generalizable. Other limitations were that the interviews were short and not audio-recorded, which may have limited the possibilities to pick up all the quotes during the interviews and in turn may have set some limitations on the thematic analysis.

Swedish school meals are publicly funded and in many cases provided by public organizations, so school catering is steered by political goals where profitability is not the highest priority. There is therefore great potential for the findings in the present study to be incorporated directly into Swedish public food service organizations. Some results can probably also be useful in other countries, as school meals are not unique to Sweden. What policymakers can learn from the present study is that there are ways to avoid the perceived goal conflict between reduced waste, more vegetarian meals, and high acceptance among pupils.

One way to enable school catering to meet multiple goals is to increase the frequency of meals that have high acceptance, have low waste levels, and are vegetarian, which in a Swedish context means e.g., pancakes, vegetarian nuggets, and vegetarian tacos. Meals that have low acceptance, that include meat, and that result in high waste, such as mixed dishes with fish or meat that include visible vegetables could be completely removed from the menu or at least served at a lower frequency. It can of course be argued that schoolchildren should be exposed to a varied diet and encouraged to try new types of foods, which are perfectly reasonable ambitions. However, if there is variation only in what is served, but not in what is eaten, such priorities will not produce

the desired results. Therefore, the cooking skills of kitchen staff could be of utmost importance in terms of developing recipes favoring children's sensory preferences, but also applying presentation techniques that appeal to pupils (Liz Martins et al., 2020; Tuorila et al., 2015). Favoring popular meals in school menus could of course increase the risk of menus becoming unbalanced. However, removing for example stews from menus containing fish, beans, or soft-cooked vegetables would not have to mean that these types of ingredients should be excluded from school menus, but they could be cooked or served in some other way instead and thus support the dietary diversity of school menus. Popular meals such as hamburgers, tacos, and meatballs could be prepared with healthier ingredients, such as plant-based meat analogues shown to be higher in dietary fiber and lower in saturated fat in comparison to meat references (Bryngelsson et al., 2022).

An ambition to serve more vegetarian meals of high acceptance would result in pupils tending to generate less waste and eat less meat. Based on the data and results of the present study, we estimate that in approximately 20% of the Swedish school menus, a switch from unpopular towards more popular meals could be made potentially resulting in up to a 2% reduction in overall food waste (420 tons/year). According to a recent forecasting study on food waste levels in 2025 in Swedish school catering, halving the 2016 level could be within reach by 2030 (Malefors et al., 2022a). However, the forecasting model also indicated a possible plateau of 5 g/guest above the target. Therefore, additional measures of different kinds are likely to be needed to ensure reaching the food waste target but attention should also be paid to ensuring high acceptance, and thus adequate intakes of schoolchildren. Removing and modifying the most unpopular meals would be an easy and quick measure to implement. Therefore, the Swedish public school food service has great potential to continue with the trend of serving less meat described by Sjölund (2021) and the trend for lowering food waste described by Malefors et al. (2022a). It would thereby contribute to sustainable development through the actual catering operations and through pupils acting as role models for the rest of society.

5. Conclusions

This study examined whether there is a goal conflict between high acceptance of school meals, reduced meat options, and decreased food wastage. The results showed that school meals with high acceptance were wasted to a lesser extent than meals with low acceptance, including vegetarian options. These results contradict the common perception that popular school meals drive plate waste, which catering staff should regard as a popular myth. A vegetarian paradox was observed throughout the interviews, with vegetarian options reported to be unpopular but with several vegetarian options among the most popular choices. School meals must meet multiple goals, but high pupil acceptance and adequate intake of nutritious school meals must be the highest priorities. Once these priorities are met, other goals, such as meeting environmental targets on reduced food waste and reduced carbon footprint, can be met in a meaningful way. There is no justification to keep on serving unpopular meals in school catering and the focus should instead be shifted to serving popular nutritious meals, including popular plant-based meal options, when striving to develop more sustainable school meal schemes.

CRediT authorship contribution statement

Niina Sundin: Conceptualization, Methodology, Visualization, Data curation, Formal analysis, Writing – original draft. **Christopher Malefors:** Conceptualization, Methodology, Visualization, Data curation, Formal analysis, Writing – review & editing. **Maja Danielsson:** Conceptualization, Methodology, Visualization, Data curation, Formal analysis, Writing – review & editing. **Marina Hardiyanti:** Conceptualization, Methodology, Visualization, Data curation, Formal analysis, Writing – review & editing. **Christine Persson Osowski:** Formal analysis, Writing – review & editing. **Mattias Eriksson:** Conceptualization, Methodology, Visualization, Funding acquisition, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Interview guide

No.	Interview question
1	What are the pupils' favorite dishes?
2	What are the students' least favorite dishes?
3	What food components in the lunch menu do the schoolchildren like the most? (Such as salad)
4	What dishes/ food components most often end up in the trash?
5	Do the students eat less or more when their favorite dishes are served?
6	Do students eat less or more when their least favorite dishes are served?
7	What kind of vegetarian dishes are served?
	How popular are vegetarian dishes in comparison with other dishes? Is there a difference in popularity within vegetarian dishes?
	Are vegetarian dishes wasted more or less than other dishes? How much more/less? Why is that?
8	Does your school measure food waste?
	Does the school have any actions to lower food waste? If yes, what are these actions?
9	Do the students change their behavior when you remind them about lowering food waste?
	Additional questions about the school
10	How old are the students at the school?
11	Is the food cooked here at the school?
12	Are there any questions from the kitchen staff?

Appendix B

Interview code	Type of interview	Type of school
001	Pilot interview	Primary school
002	Pilot interview	Primary school
003	Pilot interview	Preschool
004	Pilot interview	Primary school
005	Interview	Upper secondary school
006	Interview	Primary school
007	Interview	Primary school
008	Interview	Primary school
009	Interview	Primary school
010	Interview	Primary school
011	Interview	Primary school
012	Interview	Primary school
013	Interview	Upper secondary school
014	Interview	Primary school
015	Interview	Primary school
016	Interview	Primary school
017	Interview	Primary school

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