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Consumer perception of meal replacement beverages: A comparison between younger adults and older adults

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Abstract: Meal replacement beverages (MRBs) are consumed by a wide variety of consumers for different reasons. This study evaluated how younger adults ($n = 62$; aged 18–35) and older adults ($n = 63$; aged 65 or older) perceive MRBs. The participants started by identifying how they define MRBs. Then, the participants evaluated the sensory properties of five different chocolate-flavored MRBs using hedonic scales and the check-all-that-apply (CATA) method. Participants also identified which factors were important when consuming and purchasing MRBs. The participants highlighted that MRBs should be filling (high satiety) and have nutritional benefits. Both groups of consumers separated the MRBs based on their ingredients (plant-based or dairy-based) and liked MRBs that were sweet, chocolatey, creamy, and salty. The older adults' liking decreased due to the perception of astringency, while younger adults' liking decreased due to bitterness and off-flavors. The older adults also placed greater importance on fiber content, diabetic friendly, satiety, and calcium content than the younger adults, while the younger adults were interested in plant-based and vegan MRBs more so than the older adults. Overall, the sensory perception and hedonic liking were similar between the two groups, but their consumption factors differed.

KEYWORDS
age, beverages, consumer attitudes, protein, sensory perception

Practical Application: Understanding consumption, as well as younger and older adults' sensory perception of MRBs, should allow the food industry to create new varieties of MRBs that are well-liked by consumers of different ages. Furthermore, this study identified how consumers currently conceptualize MRBs and why they consume or are interested in MRBs.

1 | INTRODUCTION

The functional food and beverage market has recently experienced an influx due to growing consumer interest in health and the World Health Organization's focus on the health-promoting benefits of functional products (Gupta et al., 2023; Kaur et al., 2024). Additionally, due to increasing work demands and limited time for meal preparation, there has also been a consumer shift toward meal replacements and simple convenience foods (Hong, 2017; Kaur & Prasad, 2024). The functional beverage marketplace, specifically, is anticipated to grow by 7.5% annually and reach $208.13 billion by the year 2024 (Gupta et al., 2023).

Functional beverages are beverages containing bioactive or functional ingredients that have health benefits beyond hydration (Gupta et al., 2023) and can include probiotic beverages, high-protein drinks, energy drinks, antioxidant-rich drinks, fruit and vegetable drinks, and meal replacement beverages (MRBs) (Kaur et al., 2024). Typical bioactive ingredients added to functional beverages include vitamins and minerals, amino acids, peptides, phenolic compounds, and unsaturated fatty acids both from plant and animal sources (Corbo et al., 2014). From 2015 to 2017, functional beverages were considered to be the fastest-growing specialty item (Sloane, 2018). In a past study, MRBs (also referred to as ready-to-drink protein beverages) were consumed by 56% of purchasers for added protein, while 36% chose them for weight loss, 21% for exercise performance, 21% for added superfood ingredients, and 16% to support a specific health condition (Sloane, 2018). MRBs are a rapidly growing industry, and one of the reasons for this is that beverages are an effective medium for the addition of nutritional and bioactive compounds like protein, vitamins, minerals, fiber, and antioxidants (Kaur et al., 2024).

Demand for MRBs is present across different population groups. However, the application of MRBs within these populations has varied, with younger adults typically using MRBs as a weight management tool and older adults using them as a nutritional tool to prevent or minimize undernutrition and malnutrition (Allen et al., 2013; Hubbard et al., 2012). Food intake is often not adequate in older adults compared to younger adults (Field & Duizer, 2016), with close to 10% of older adults believed to be experiencing undernutrition (Doets & Kremer, 2016). In older adults, common physiological and sensory-specific changes occur, like decreased appetite and impairment of taste and smell, which can lead to disinterest in food (Leslie & Hankey, 2015). Moreover, the older adult population (60 years or older) is expected to reach 2 billion by the year 2050 while experiencing a 3% annual growth rate (Regan et al., 2019). Ensuring that the older adult population is able to meet nutritional requirements is key to health and the maintenance of quality of life (Doets & Kremer, 2016; Leslie & Hankey, 2015). People with dementia or who have experienced cognitive decline, for example, are at increased risk for undernutrition due to higher reliance on others as well as poor eating behaviors, thereby requiring supplemental MRBs to maintain weight and decrease malnutrition risk (Allen et al., 2013).

Malnutrition is known to contribute to impaired quality of life, delayed recovery, poorer health outcomes, and increased risk of both mortality and morbidity (Stratton et al., 2003; Taylor, 2020). MRBs have a key role in preventing and managing malnutrition (Hubbard et al., 2012). MRBs may also help reduce mortality and complications across various patient groups and health conditions, such as chronic renal disease, cancer, and diabetes, as well as improve surgery outcomes and aid in instances of infection or pressure ulcers (Stratton & Elia, 2007). Another reason MRBs are often used and supported is that they have higher compliance rates (78%) within both hospital and community environments (Hubbard et al., 2012). MRBs have also been utilized as a popular weight management tool that is a prepackaged, calorie-controlled product, which has been validated as safe and effective for weight loss (Stratton & Elia, 2007). Appetite and lunch consumption have been shown to significantly decrease with the consumption of an MRB prior to lunch in healthy adults aged 18–58 (Allen et al., 2013).

Differences in sensory perception and preference of MRBs have been suggested to exist across different populations (Doets & Kremer, 2016; Regan et al., 2019, 2021). Enhancing the sensory properties of MRBs may be necessary in order to increase consumer acceptance. Evidence suggests the existence of an interactive effect between the nutritional composition and sensory characteristics of a beverage product on satiety (Chambers et al., 2013; Yeomans & Chambers, 2011). Both savory and sweet replacement beverages have been found to have better consumer acceptance in relation to sensory characteristics, while saltiness was shown to have a negative effect on acceptability (Kaur & Prasad, 2024). However, in older adult populations, elevated sweetness contributes to dislike of MRBs (Kennedy et al., 2010). Protein type has also been shown to contribute to differences in both flavor and texture of beverages and bars (Childs et al., 2007). Some existing studies on MRBs have shown acceptance of new formulations such as a pea-based protein formula (Mazlan & Malik, 2023). However, sensory challenges remain prominent with added functional ingredients in MRBs and new formulations especially when it comes to textural changes (Childs et al., 2007). Whey protein is a common form of protein added to MRBs, which has been

shown to be cohesive, whereas alternative protein sources like soy protein added to MRBs have been suggested to result in grainy flavors and texture, thereby impacting the overall sensory acceptance of the MRB (Childs et al., 2007).

Additional research is needed to better understand how different populations perceive the sensory attributes of MRBs and their overall liking. This study will seek to understand whether perceived MRB differences exist in younger and older adults. The check-all-that-apply (CATA) method will be applied to help identify sensory characteristics in both population groups. CATA is commonly used to assess sensory attributes of food and beverage products through which consumers are asked to select descriptive attributes that best describe the product they are sampling from a list of provided attributes (Ares & Jaeger, 2023; Ares et al., 2015; Cardinal et al., 2015). CATA will help to better understand consumer preferences, factors that may drive overall liking, and differences that may exist between both groups.

This research aimed to evaluate how younger adults (18–35 years old) and older adults (65 years of age and older) perceive MRBs. The participants evaluated MRBs for their sensory properties. They also identified what aspects of MRBs are individually important and what drives their purchase of MRBs.

2 | MATERIALS AND METHODS

The study was reviewed and approved by the Acadia University Research Ethics Board (REB #13-72).

2.1 | Participants

The study had a total of 126 participants (62 participants aged 18–35 years, and 64 participants aged 65 years or older). The participants were recruited for the study if they self-identified that they currently consume MRBs or if they are interested in MRBs. The younger adults ($n = 62$) included 40 females and 22 males, while the older adults ($n = 63$) included 43 females and 21 males. All participants lived in the Annapolis Valley (Nova Scotia, Canada) and gave informed consent before participating in the study. The study was conducted in accordance with the Declaration of Helsinki.

2.2 | Sample preparation

Samples were selected based on a preliminary survey ($n = 102$) that asked participants to identify MRBs that they are familiar with. The commercial MRBs that were included in the study were labeled as meal replacements, chocolate-flavored, and available in a ready-to-drink format (not powder and then mixed by the consumer). The ingredients of each sample are included in Table 1. Batch numbers for each sample were matched to ensure consistency. Each sample (30 mL) was presented in clear sample cups at 10°C (Childs et al., 2007). The sample presentation was balanced to account for possible carryover effects of preceding samples and was based on designs from (Macfie et al. 1989).

2.3 | Sensory procedure

Participants completed their testing in the Centre for the Sensory Research of Food (Acadia University, Wolfville, Nova Scotia, Canada) in individual sensory booths using the Compusense software (Compusense) using computers. The participants were informed about the objective of the study and the ingredients in the samples, and the testing procedure was briefly explained. Once seated in the sensory booths, the participants were presented with an open-ended comment question asking them to define MRBs. They were then asked to identify which attributes are important to them when purchasing/consuming MRBs using a CATA question (including the attributes: flavor, price, ingredients, plant-based, vegan, keto-friendly, protein content, fiber content, sugar content, fat content, sweeteners, glycemic index, diabetic friendly, organic, non-GMO, sustainable, gluten-free, texture, source of omega-3, keeps you full, muscle building, high in calcium, vitamins and minerals, natural, heart health) (Childs et al., 2007, 2008; Collins et al., 2009; Hartmann et al., 2016; Jovanov et al., 2021; Kaur et al., 2024; McCrickerd et al., 2020; Miraballes et al., 2014). Then, participants indicated how important different health benefits are to them using a 7-point scale (ranging from 1 = *Not at All Important* to 7 = *Extremely Important*). The participants then evaluated the samples one at a time using the 9-point hedonic scale for their overall liking, as well as liking of appearance, aroma, flavor, and texture/mouthfeel. Participants were then asked to describe the sensory properties of each sample using a CATA question, including the following attributes: sweet, gritty, sandy, thick, thin, sour, salty, bitter, metallic, astringent, cooked, grainy, nutty, chalky, cardboard, aftertaste, creamy, watery, mouthcoating, fruity, and beany (Childs et al., 2007, 2008; Deshpande et al., 2005; Liu et al., 2021; Moss et al., 2022; Prindiville et al., 2000; Teixeira et al., 2020; Vogel et al., 2021). There was a 1-min break between samples, in which participants were instructed to cleanse their palate. Participants then answered demographic questions (age, gender, and if they were following any special diet).

TABLE 1 Ingredients included in the chocolate meal replacement beverages.

Product (g of protein per 240 mL serving)	Ingredients
MRB1 (10.0 g of protein)	Water, corn syrup, milk protein, sugar, vegetable oils (canola, high oleic sunflower and corn), soy protein, salt, vitamins (vitamin A palmitate, vitamin D3, DL-alpha-tocopheryl acetate, sodium ascorbate, ascorbic acid, thiamine hydrochloride, riboflavin, niacinamide, calcium pantothenate, pyridoxine hydrochloride, biotin, folic acid, choline bitartrate), minerals (sodium citrate, potassium citrate, potassium hydrate, potassium chloride, calcium carbonate, tricalcium phosphate, magnesium phosphate, ferrous sulfate, zinc sulfate, manganese sulfate, copper sulfate, potassium iodide, sodium selenite, sodium molybdate, chromium trichloride), cellulose gel and gum, soy lecithin, flavor, carrageenan, stevia extract, dimethylpolysiloxane.
MRB2 (12.0 g of protein)	Water, milk protein concentrate, corn maltodextrin, soy protein isolate, sugar, cocoa powder (processed with alkali), canola oil, less than 0.5% of vitamins and minerals (potassium citrate, sodium ascorbate, sodium citrate, choline chloride, magnesium phosphate, potassium chloride, DL-alpha-tocopheryl acetate, ferrous sulfate, zinc sulfate, niacinamide, calcium pantothenate, manganese sulfate, pyridoxine hydrochloride, thiamine hydrochloride, riboflavin, copper sulfate, vitamin A palmitate, folic acid, potassium iodide, sodium selenate, sodium molybdate, chromium chloride, phylloquinone, biotin, vitamin D3, vitamin B12), natural and artificial flavors, cellulose gel, salt, carrageenan, cellulose gum, acesulfame potassium, gellan gum, sucralose.
MRB3 (10.3 g of protein)	Water, skim milk powder, sugar, fructose, calcium caseinate, canola oil, cocoa powder, cellulose gel, corn oil, natural & artificial flavor, gum arabic, soy lecithin, cellulose gum, monoglycerides and diglycerides, carrageenan, corn maltodextrin, dextrose, vitamins and minerals: dipotassium phosphate, sodium citrate, magnesium phosphate, sodium ascorbate (vitamin C), dicalcium phosphate, ferric orthophosphate (iron), niacinamide (vitamin B3), vitamin E acetate, vitamin A palmitate, manganese sulfate, biotin, zinc oxide, copper sulfate, calcium pantothenate, cholecalciferol (vitamin D3), thiamine mononitrate, pyridoxine hydrochloride (vitamin B6), riboflavin, cyanocobalamin (vitamin B12), folic acid, sodium molybdate, sodium selenite.
MRB4 (11.6 g of protein)	Water, pea protein, hemp protein, tapioca maltodextrin, tapioca syrup, maple syrup, sunflower oil, safflower oil, natural flavors, cocoa powder, hemp seed oil, vitamin and mineral blend: calcium phosphate, magnesium phosphate, calcium carbonate, ascorbic acid (vitamin C), niacinamide, DL-alpha tocopheryl acetate, zinc gluconate, D-calcium pantothenate, ferric orthophosphate, thiamine mononitrate, vitamin A palmitate, pyridoxine hydrochloride (vitamin B6), copper gluconate, riboflavin (vitamin B2), folic acid, potassium iodide, biotin, sodium molybdate, chromium chloride, sodium selenite, cholecalciferol (vitamin D3), cyanocobalamin (vitamin B12), sunflower lecithin, tara gum, sea salt, DHA-rich algal oil, gellan gum, rosemary, mixed tocopherols.
MRB5 (14.5 g of protein)	Water, maltodextrin, soy protein isolate, high oleic sunflower oil, palatinose, cocoa powder, canola oil, artificial flavor, soluble corn fiber, chocolate flavor naturally fortified, soy lecithin, tricalcium phosphate, potassium chloride, magnesium phosphate, ascorbic acid, cellulose, salt, choline chloride, gellan gum, antifoam solution (polydimethylsiloxane, water, surfactants), sucralose, DL-alpha-tocopheryl acetate, D-calcium pantothenate, niacinamide, ferrous bisglycinate, zinc oxide, copper gluconate, thiamine hydrochloride, manganese sulfate, pyridoxine hydrochloride, riboflavin, vitamin A palmitate, chromium chloride, biotin, potassium iodide, folic acid, sodium molybdate, sodium selenite, phytonadione, vitamin D, vitamin B12.

TABLE 2 Results of the comment analysis asking the participants (both younger and older consumers) to define meal replacement beverages.

Table	Examples of responses
Satiety	Heavy, replaces normal meal, makes you feel full, filling
Nutritional value	Nutritional value, complete dietary needs, nutritional requirements, balanced meal, nutrients, daily required nutrients, vitamin enriched, comprehensive dietary needs
Convenience	Replaces meal, drink when you can eat a meal, on the go, eat it quickly
Weight loss	For someone trying to lose weight, needed for weight loss, diet, losing weight
Protein	Source of protein, fortified with protein, high protein, protein drink, lots of protein
Beverages	Smoothies, meal in beverage form, liquid form, ready to drink, milkshakes
Replace a meal	All required nutrients that I would usually get from a meal, replaces a meal, drink it so you don't have to eat
Energy	Energy that a meal would normally have, caloric intake, needs to have enough calories, should be low calories
Product names	Boost, Ensure
Disliking	Stupid, processed, shouldn't replace a meal, would never drink one, full of artificial ingredients, yuck, unnatural

2.4 | Statistical analysis

Participant responses to the open-ended comment question about MRBs were visualized using the Compusense software, and key concepts in the responses were identified following the method of Fonseca et al. (2016). The results were discussed among the authors to reach a consensus. The liking responses of MRBs from the older and younger adults were compared using a *t*-test. The younger and older adults' responses to the CATA question, including the sensory attributes, were analyzed using the procedure of Meyners et al. (2013), which includes a Cochran's Q test, followed by pairwise comparisons using Sheskin's critical differences. Correspondence analysis considered the responses from the younger and older adults to be a separate sample. Furthermore, a penalty lift analysis (adapted from Meyners et al. [2013]) was completed. The biplot based on the correspondence analysis for the younger and older consumers was compared using RV coefficients (Vidal et al., 2015). The attributes of MRBs that were identified as important by the younger and older consumers were compared using a chi-squares test. All analyses were conducted using XLSTAT software in Microsoft Excel.

3 | RESULTS AND DISCUSSION

Participants identified how they define MRBs in an open-ended comment question, and the results are listed in Table 2. The responses from the older and younger consumers were compared, but similar trends were identified; therefore, the responses are presented together in Table 2. Participants identified that they believe MRBs should lead to satiety and replace a meal. This agrees with the purpose of MRBs (Stull et al., 2008), and as identified by Oltman et al. (2015), satiation is a key attribute of MRBs. Protein was also identified, and this also agrees with the past study by Oltman et al. (2015). They also associated MRBs with nutritional value, energy, and the previously mentioned protein; therefore, they believed that MRBs have nutritional benefits. In agreement with this study, a past study on meal replacements identified that consumers are interested in nutritional facts and pay particular attention to caloric and protein contents (Miraballes et al., 2014). However, Miraballes et al. (2014) also found that consumers were interested in fat content, which was not in agreement with the present study. Previous studies also identified that MRBs should be used for weight loss, which agrees with the marketing of these beverages (Hartmann et al., 2016; Haynes et al., 2022; Miraballes et al., 2014). The participants stated different types of beverages (smoothies, milkshakes) and brand names, showing that they are familiar with several types of MRBs. Lastly, some participants had negative responses; participants felt MRBs were "unnatural" or "processed." If consumers believe that food is processed or ultraprocessed, it can lead to disliking (Barrett et al., 2020), and this result was found when evaluating MRBs.

After the open-ended comment question, the participants consumed five different MRBs and evaluated their liking (Table 3) and sensory perception (Figure 1a,b). There were very few differences in the participants' liking of the samples. The older adults ($n = 63$) did not identify any significant differences between the MRBs, except for the appearance, with the MRB3 being liked significantly less than the MRB1 ($p < 0.05$). The younger adults disliked MRB3 significantly more than MRB1 and MRB2 ($p < 0.05$). The younger adults found significant differences in their

TABLE 3 Consumer mean liking scores (± standard deviation) for appearance, aroma, taste, mouthfeel, and overall liking for the different meal replacement beverages (separated into younger and older consumer groups).

Sample		Appearance	Aroma	Taste	Mouthfeel	Overall liking
Older[a]	MRB1	6.2a ± 1.1	**5.3a** ± 1.4	**5.1a** ± 1.5	4.6a ± 1.6	**4.8a** ± 1.1
	MRB2	**5.6ab** ± 1.5	**4.9a** ± 1.5	5.0a ± 1.3	4.6a ± 1.3	**4.8a** ± 1.4
	MRB3	5.0b ± 1.3	5.9a ± 1.5	5.4a ± 1.5	5.2a ± 1.1	5.2a ± 1.0
	MRB4	5.9ab ± 1.6	5.7a ± 1.2	4.9a ± 1.2	5.4a ± 1.4	5.4a ± 1.2
	MRB5	5.5ab ± 1.2	5.8a ± 1.5	5.1a ± 1.3	5.1a ± 1.0	5.1a ± 1.1
Younger[b]	MRB1	6.5a ± 1.2	**6.3a** ± 1.3	**6.3a** ± 1.5	4.3b ± 1.5	**6.3a** ± 1.1
	MRB2	**6.3ab** ± 1.5	**6.3a** ± 1.6	5.3ab ± 1.2	4.3b ± 1.0	**6.1a** ± 1.4
	MRB3	5.0c ± 1.3	5.6ab ± 1.4	5.1ab ± 1.5	5.0ab ± 1.6	5.9a ± 1.3
	MRB4	5.4bc ± 1.2	5.1a ± 1.2	4.7b ± 1.2	5.0ab ± 1.4	6.0a ± 1.2
	MRB5	5.6abc ± 1.4	5.7ab ± 1.5	5.2ab ± 1.4	5.5a ± 1.7	5.7a ± 1.1

Note: All data refers to a 9-point hedonic scale, where 1 = *Dislike Extremely*, 5 = *Neither Like or Dislike*, and 9 = *Like Extremely*. Means in the same column within the same consumer group, with the same letter, are not significantly different at $\alpha = 0.05$. Significant differences between the two groups (older and younger) are bolded and underlined ($\alpha = 0.05$).

[a] $n = 63$.

[b] $n = 62$.

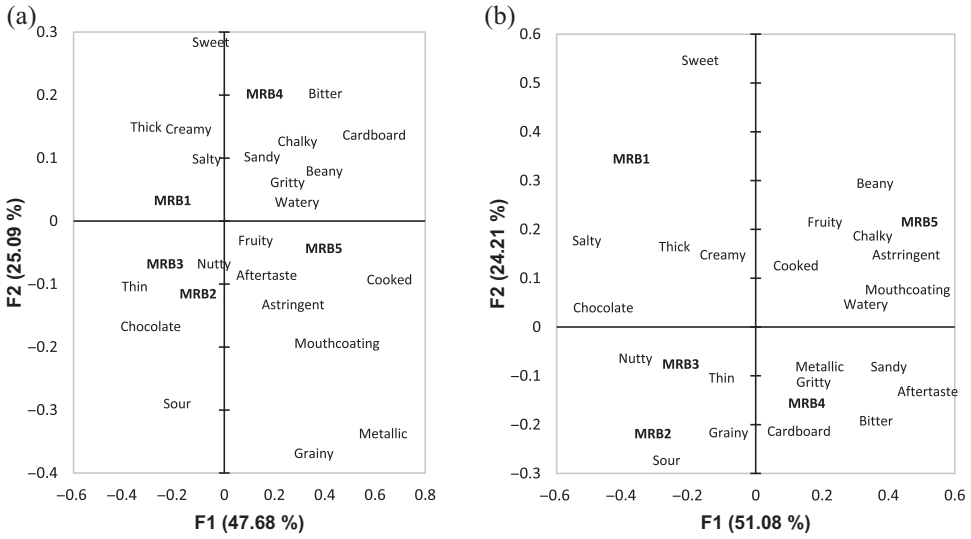

FIGURE 1 Biplot representation of the meal replacement beverage (MRB) samples and their sensory attributes as evaluated by the older consumers (a) and younger consumers (b). Both biplots are based on the first two dimensions of the correspondence analysis.

liking of the aroma, taste, and texture, but similar to the older adults, there were no significant differences in the overall liking. This is an interesting result, as differences in the liking of flavor and texture usually influence overall liking (Andersen et al., 2019; Moskowitz & Krieger, 1995). However, this result may be due to consumers associating MRBs with their nutritional composition or health benefits rather than their sensory properties (outlined in Table 2). A possible explanation for the lack of difference in the overall liking of the MRBs between younger and older adults (Table 3) could be that consumers did not identify sensory properties when defining MRBs in the open-ended comment question. Moreover, both younger and older adults may have evaluated their overall liking based on the perceived benefits of MRBs rather than sensory perception or liking. A past study on vanilla commercial MRBs found that they had different sensory properties (Liu et al., 2021), and the MRBs in this trial also had different sensory properties as evident in the CATA results (Figure 1); however, this did not impact their overall liking scores of the participants. Future studies should use a trained panel and consumer acceptability trial, as well as preference mapping to identify differences in the sensory properties of chocolate MRBs, as well as drivers of liking.

Significant differences did exist between the hedonic scores for the younger and older adults. The younger adults

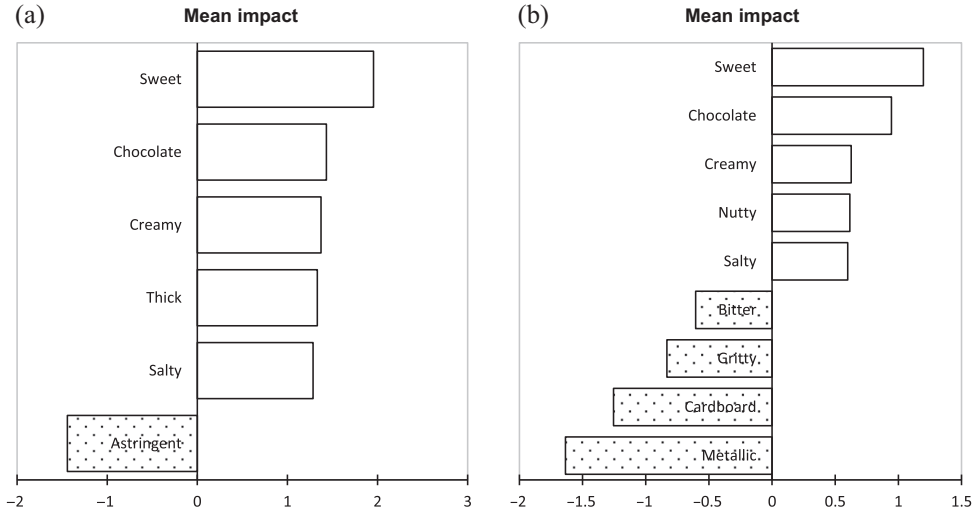

FIGURE 2 Penalty lift analysis of the sensory attributes and overall liking based on the older consumers' (a) and the younger consumers' (b) evaluation of the meal replacement beverages (MRBs).

significantly liked the MRB1 and MRB2 more than the older adults ($p < 0.05$). Furthermore, they liked the taste of MRB1, the aroma of MRB1 and MRB2, and the appearance of MRB2 more than the older adults ($p < 0.05$). Generally, the younger adults' liking scores for the MRBs were higher than the older adults. This result may be due to the aging process in humans leading to a decline in orosensory functions, which can impact sensory perception of food products (Kremer et al., 2007; Song et al., 2016). However, Doets and Kremer (2016) concluded that younger adults and older adults did not seem to differ in their initial hedonic appraisal of food products, which disagrees with this finding. In this study, the younger consumers liked the MRBs significantly more than the older adults. In agreement with this study, a past study comparing younger and older adults' sensory perception of oral nutritional supplements found differences in their flavor perception (Regan et al., 2019). Similarly, Regan et al. (2019) also found differences in the textural perception of the two consumer groups, but this was not found in the liking scores of this study and will be further explored using the CATA question. Oral status (state of mouth, teeth, and orofacial structures) has also been found to influence the sensory perception of oral nutritional supplements (Lester et al., 2022), and older adults usually have poorer oral health than younger adults (Field & Duizer, 2016). Future studies investigating MRBs may want to evaluate the influence of oral status.

The younger and older adults similarly evaluated the MRBs using the attributes in the CATA question. In both biplots (Figure 1a,b), the MRB1, MRB2, and MRB3 samples were separated from the MRB4 and MRB5 samples by the first dimension, and the second dimension separated MRB4 from MRB5 in both biplots. Both biplots found that the MRBs were separated by flavor attributes, with off-flavors (e.g., cooked, astringent, aftertaste) on the positive side of the first dimension and chocolate on the negative side of the dimension. Also, the first dimension separated the samples based on the presence of mouthcoating. The second dimension separated the samples based on sweetness (on the positive side) and sourness (on the negative side). Both older and younger adults appeared to separate the MRBs based on the presence or absence of dairy ingredients, as both MRB4 and MRB5 were manufactured from plant-based ingredients including pea protein and hemp protein. Pea protein and hemp protein have been associated with bitter, astringent, and beany attributes in past studies (Amyoony et al., 2024; Cosson et al., 2020; Liu et al., 2021; Tireki, 2021; Trikusuma et al., 2020). Furthermore, the plant-based MRBs were associated with mouthcoating, grainy, gritty, sandy, and chalky textures, a finding that has also been found in past studies (Amyoony et al., 2023; Chung et al., 2022; Giacalone et al., 2022; Sakthi et al., 2020). MRB1 was separated from the other dairy-based MRBs based on its textural properties, as MRB1 was associated with thick and creamy, while MRB2 and MRB3 were associated with thin. Both groups of consumers separated the samples based on their ingredients. The RV coefficient comparing the biplots of the older and younger consumers confirms these results, indicating that the configuration of the samples is quite similar (RV = 0.656).

The penalty lift analysis (Figure 2) identified that sweet, chocolate, creamy, and salty are important to both groups of consumers. Sweetness, chocolate, and saltiness have been identified as attributes of MRBs in a past study (Childs et al., 2007). Based on these results, they increase consumer liking of MRBs. Furthermore, creaminess can increase expectations that a drink will be filling and

satiating (McCrickerd et al., 2012). Consumers identified in this study that they want MRBs to be filling (Table 2). Past research has identified that in comparison to younger adults, older adults perceive the creaminess of food to be lower (Kremer et al., 2005, 2007); however, creaminess is still a driver of liking for older adults. The other two attributes that increased liking were thick (identified by the older adults) and nutty (identified by the younger adults). Kremer et al. (2005) found that both younger and older adults can perceive differences in thickness similarly, but based on the results, older adults prefer thick MRBs. This result may be once again due to the fact that similar to creaminess, the thickness of a beverage is associated with higher satiety (Regan et al., 2019) due to the beverage being consumed at a slower rate —which increases satiety (Chambers, 2016; den Boer et al., 2019). The only attribute that decreased older adults' liking of the MRBs was astringency. This result could be due to older adults being more sensitive to mouth drying (Withers et al., 2013). Astringency is commonly referred to as a dry mouthfeel. Also, many consumers do not know the meaning of astringency (Childs & Drake, 2010), and a limitation of this study is that older adults may have had a better understanding of astringency, but the participants' understanding of astringency was not assessed in this study. Future studies should define astringency for consumers. Furthermore, future studies should investigate if consumers' understanding of astringency is impacted by age. It is also interesting to note that Zhang et al. (2020) identified astringency as a driver of disliking of MRBs in a home-use test but not when the study was conducted in a sensory lab. The results may have differed between the two studies, as Zhang et al. (2020) utilized participants aged 18–54 years of age, while the older adults in this study were 65 years of age or older, and as stated above, older adults are more sensitive to mouth drying. Future studies should confirm these results using a larger sample serving or a home-use test, as Withers et al. (2014) identified that increased consumer perception of astringency is correlated to a larger consumption volume. The younger adults identified that bitterness, gritty, cardboard, and metallic all decreased their liking of the MRBs. The differences in results may be because older adults have been found to perceive a lower flavor intensity than younger adults (Doets & Kremer, 2016).

Participants were asked which attributes are important to them when purchasing or consuming MRBs; the results are presented in Table 4. The younger adults selected plant-based, vegan, and muscle-building significantly more than the older adults. Past studies have identified younger adults are more likely to eat plant-based alternatives and follow a vegan diet (Haas et al., 2019; Ohlau et al., 2022), and protein sources can impact consumers' preference toward protein-fortified products including MRBs (Keefer et al., 2024). Furthermore, younger Canadian adults are thought to be interested in muscle building (Ganson et al., 2023). The older adults had a greater interest in fiber content, diabetic friendly, satiety, and calcium than younger adults. Research has shown older adults are interested in increased dietary fiber and calcium, as higher consumption of these two nutrients by older adults has been widely promoted in marketing materials (Doma et al., 2019; O'Brien et al., 2024). As discussed above, all consumers in the study were interested in satiety. The older adults were more interested in diabetic-friendly claims, as older adults are more likely to be diabetic than younger adults (Thibault et al., 2016). Although consumers were not asked about their health status (e.g., type 2 diabetes, etc.), future studies should investigate how health status

TABLE 4 The frequency of the attributes selected as important by older ($n = 63$) and younger ($n = 62$) older consumers when purchasing/consuming a meal replacement beverage.

Attribute	Older ($n = 63$)	Younger ($n = 62$)
Flavor	19	15
Price	24	16
Ingredients	10	4
Plant-based	**12**	**20**
Vegan	**2**	**9**
Keto friendly	9	4
Protein content	13	16
Fiber content	**26**	**8**
Sugar content	10	5
Fat content	3	8
Sweeteners	13	10
Glycemic index	4	1
Diabetic friendly	**37**	**10**
Organic	29	27
Sustainable	5	5
Gluten-free	14	11
Texture	14	12
Source of omega-3	3	8
Keeps you full	**20**	**9**
Muscle building	**3**	**11**
Calcium	**14**	**4**
Vitamins and minerals	11	7
Natural	9	6
Heart health	18	11

Note: Bolded values indicate a significant difference based on a chi-squared test ($p < 0.05$).

TABLE 5 Importance of the different claims (means ± standard deviation) as evaluated by older consumers ($n = 63$) and younger consumers ($n = 62$).

Claim	Older consumers	Younger consumers
High fiber	5.8a ± 1.3	5.2b ± 1.4
High protein	5.7a ± 1.2	5.8a ± 1.0
Low fat	4.1a ± 1.1	4.1a ± 1.2
Low sugar	5.6a ± 1.4	4.9b ± 1.5
No artificial sweeteners	4.8a ± 1.3	4.6a ± 1.5
Organic	4.1a ± 1.1	3.9a ± 1.2
Gluten-free	1.9a ± 1.2	1.8a ± 1.3
Dairy-free	2.2a ± 1.4	2.3a ± 1.1
Keto-friendly	1.8a ± 1.0	2.0a ± 1.3

Note: All data collected on a 7-point scale, where 1 = *Not At All Important* to 7 = *Extremely Important*. Means in the same row, with the same letter, are not significantly different at $\alpha = 0.05$.

influences consumers' beliefs about MRBs. Reinforcing these results are the consumers' responses to the different claims identified in Table 5. Similar to the results in Table 4, older adults identified that the high-fiber and low-sugar claims were significantly more important than the younger adults ($p < 0.05$). The older and younger adults have similar liking scores and sensory perception of the MRBs, but based on the attributes and claims identified in Tables 4 and 5, they are interested in MRBs for different reasons.

Future studies should continue to evaluate the sensory properties of MRBs, as this study only included ready-to-drink beverages that are currently available in Nova Scotia, Canada. As stated above, future studies could use a trained panel and consumer acceptability trial to evaluate differences in sensory properties and drivers of liking of chocolate MRBs. Furthermore, future research should couple sensory evaluation studies with satiety studies, as satiety was identified as important to all consumers. This study asked the consumers to drink a sample (30 mL) of the MRBs, but future studies should ask the participants to drink a whole serving (240 mL) of the MRBs to investigate how the consumption rate and volume influence sensory perception and liking. As stated above, the influence of health status and dental status on consumer perception of MRBs should also be identified. Evaluation of the rheological properties of each MRB and how it correlates with consumer perception could also be considered in future research. Future studies should be conducted with larger sample sizes (this study used 63 older adults and 62 younger adults) to confirm these results. Also, future studies should investigate whether consumers are most likely to consume MRBs, as the differences in the reasons for consumption identified in this paper may lead to different consumption environments.

4 | CONCLUSION

This study identified that younger and older adults' sensory perception of chocolate MRBs is similar, but the reasons for consumption differ. Both groups of consumers separated the MRBs based on their ingredients (plant-based or dairy-based), and they are interested in MRBs that are sweet, chocolatey, creamy, and salty. The older adults identified that astringency decreased their liking, while younger adults identified that it was bitterness and off-flavors that decreased their liking. Although sensory perception of the MRBs was similar between both groups, the older adults placed a greater importance on fiber content, whether the MRBs were diabetic friendly, satiety, and calcium content compared to the younger adults. The younger adult group also had a greater interest in plant-based and vegan MRBs than the older adults. This study identifies how younger and older adults envision MRBs and how they could be marketed to two different groups for nutritionally different reasons. Furthermore, this study identifies what sensory attributes increase the liking of MRBs. Future studies should continue to investigate the sensory properties of MRBs and relate their findings to health status, dental status, and satiety.

AUTHOR CONTRIBUTIONS

Rachael Moss: Writing—original draft; writing—review and editing; investigation. **Mackenzie Gorman**: Investigation; writing—original draft; writing—review and editing. **Allison Stright**: Investigation; writing—original draft; writing—review and editing. **Emily Dolan**: Investigation; writing—original draft; writing—review and editing. **Matthew Code**: Investigation; writing—original draft; writing—review and editing. **Matthew**

B. McSweeney: Writing—original draft; writing—review and editing; project administration; resources; supervision; conceptualization; investigation; funding acquisition.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on request from the corresponding author (M.M.).

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